

**Design Studio #4 - Weekly Progress Report #8**

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In the previous week, we conducted various experiments with our video transmission system and with our RC controller system. The experiments were performed under various conditions to observe the limits of the systems. First, we tried to observe how far the video is displayed in line of sight and we concluded that it was more than enough for our project since it went as far as 100m and the there was not a single deterioration in the video. Then, we carried out the experiment in the D building where there are lots of walls and obstacles between the transmitter and the receiver. The system worked really fine again when the distance between the transmitter and the receiver was about 45m with all the obstacles in the way. Finally, we tried the system when the transmitter and the receiver are in different levels of floor and the system worked successfully when there was 1 floor difference between the transmitter and the receiver. The RC controller also proved successful under each condition where it was tried by controlling two servo motors on two channels.

Having observed the success of the systems, we started to think on how to reduce the price of the equipments without affecting the performance of the systems so that they will not perform as required because the components that we made the experiments with are too expensive for our project. Therefore, an intense research period has become on the literature and on different applications available online. Current findings of the research are as follows:

The receiver should be of diversity type where two antennae are used simultaneously and the one that gives more stable data is used at any time to avoid loss of data. The receiver that we experimented with is of this type and it has two directional antennae. Directional antennae have very small gains in every direction except in the direction it is pointed. The radiation pattern of a directional antenna is shown in Figure 1.

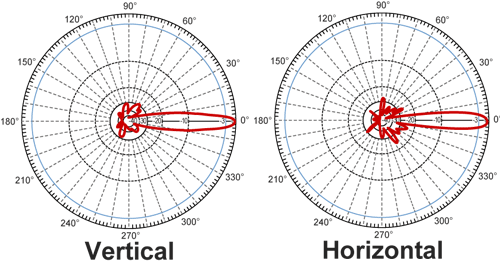


Figure 1: The radiation pattern of a directional antenna.

Also, there are omnidirectional antennae which have a symmetrical radiation pattern. The radiation pattern of an omnidirectional antenna is shown in Figure 2.

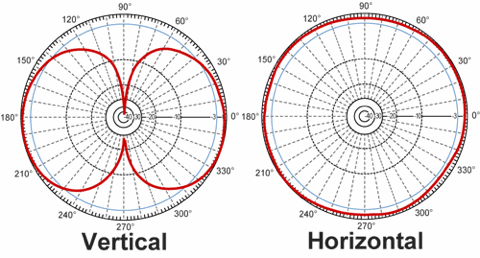


Figure 2: The radiation pattern of an omnidirectional antenna.

As seen in Figure 2, the gain of an omnidirectional antenna is almost the same in every direction except its perpendicular sides. Observing the two radiation pattern in Figure 1 and Figure 2, we can conclude that we should use a directional and an omnidirectional antenna together in a diversity receiver so that we will obtain more range in one direction and a considerable range in every direction since our robot will move in different directions but it will have a dominant direction when the receiver remains where it is. There are some diversity receivers on the market that are cheaper than the one we have now but their quality is open to question. Also, the receiver we currently have has an output of composite video which is a very old video format and it is difficult and expensive to convert to VGA or some other format. Therefore, we will make research about receivers that have an output video format that can be displayed on a modern monitor or on a smartphone, or we will use a receiver of the same type and display the video on an AV monitor like the one we have now. We can only decide after choosing majority of the components and after some experimentation with other receivers.

The transmitter that we experimented with is a very powerful transmitter which is also very expensive. We will use an omnidirectional antenna on the transmitter since the robot will move in different directions. The propagating wave will be circularly polarized since linearly polarized waves can not penetrate through objects in the propagation direction very easily. Also, with a circularly polarized wave, the chance of multipath interference is reduced considerably since the polarization of the wave switches when the wave reflects from an obstacle. In other words, the wave will become left hand polarized after hitting an object if it was right hand polarized originally causing the receiver antenna to ignore this out of phase wave avoiding multipath interference. The transmitter has an output signal of 2000mW which is considered too much in drone applications since it causes interference more easily. We should find the transmitter with the minimum output power to avoid this interference and help reduce its cost since a low power transmitter is cheaper usually. We should decide on the transmitter after experimenting with different ones that have different output powers.

A budget analysis is made considering the most expensive and the cheapest of every component. The components of which we are not certain can be chosen according to this analysis. The above mentioned budget analysis is shown in Table 1.

The price of the mechanics of the robot is not included in the analysis since it is not certain how we will implement the physical mechanisms of the robot yet. The price for the mechanics left if all the components are bought with the minimum price is 79$ which is more than enough for the robot. However, with the most expensive equipment, the budget is exceeded even without the mechanics included. Therefore, some parts of the system that are not very critical should be chosen with the minimum price while more important parts should be chosen with a reasonable quality to make space for the mechanics of the robot. This budget analysis forces us to design the RC controller ourselves since the products on the market are too expensive. The FPV camera we experimented with is a high quality camera belonging to a very famous brand called FatShark and it is too expensive. Also, it works with a very narrow voltage range which forces us to use a voltage converter increasing the price. We are looking for the ones that are cheaper, lower video quality and more wide angle to see more area in the field.

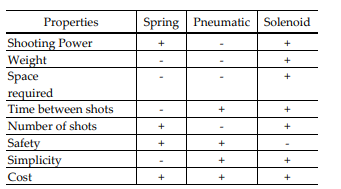
In order to choose all the components, we will first try to obtain some products without spending money and experimenting with them under different conditions. When we are convinced that the components will most probably work or we cannot procure some of the products without buying them, we will buy the components and experiment with them. While choosing the best components for our project, we will also make research about the mechanics of the robot. When the shape of the mechanics become more clear, we will have a better estimation of its price and we can add what is left of its expected budget to other components to increase the quality of the system.

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| --- | --- | --- |
| Component | Minimum Price | Maximum Price |
| Video Transmitter | 11$ | 36$ |
| Video Receiver | 15$ | 28$ |
| AV Monitor | 15$ | 25$ |
| FPV Camera | 10$ | 50$ |
| RC Controller | 20$ | 50$ |
| Battery | 10$ | 30$ |
| DC Motor (x2) | 5$ | 15$ |
| Servo Motor (x2) | 2$ | 10$ |
| HC SR04 (x4) | 1$ | - |
| Line Follower Sensor(x4) | 2$ | - |
| Motor Driver | 5$ | 10$ |
| Wheels(x2 or x4) | 1$ | 6$ |
| Ball | 2$ | - |
| Walls | 5$ | - |
| Total | 121$ | 322$ |

Table 1: A rough budget analysis showing the price of every component.

(Recep Günay)

While ruminating over the best choice of a shooting system for our robot, I came up with three possibilities: Spring, Pneumatic or Solenoid based. The table below weighs the pros and cons of each option and therefore summarizes my findings succinctly,



Pneumatic:

In this mechanism, a huge tank will be designed and installed somewhere in the Robot, then pneumatic jacks which are connected to the gas resource, will be established in front of the Robot or on some sides of it. The gas resource will be filled before the match. Because in the pneumatic jacks switch actions are done through solenoid, we can somehow control the stroke. In general, the following cases are some defects of the above system: The strength of the stroke depends on the amount of gas in the tank, it requires a lot of space.

Solenoid based:

The third idea for a shooting mechanism is an inductive resistance in which, when current passes, a magnetic field will be created. When we increase the number of cycles or the amount of electricity, there will be a stronger magnetic field. Magnet materials can be attracted or repelled through a magnetic field and this is a phenomenon which is used in building a solenoid. Since the available solenoids are flat and wide and have low voltage, they have a fairly slow movement, so they are not suitable for shooting mechanisms. The solenoids for shooting should be fast and should require a small space.

Spring Based

The first kind of stroke mechanism is the one based on storing energy in a spring through a DC engine. One of the outstanding properties of this mechanism is its simplicity. The spring, in this system, is contracted and maintained through a DC engine and is released at a determined time. If this system is well designed, we can store a lot of energy in the spring. The number of strokes in this mechanism are unlimited and it just depends on the battery. This system has some defects such as: the large space it requires, its high weight, the amount of time it takes to recharge and the main defect of the shooting mechanism through spring is that controlling the force for shooting is difficult.

After a thorough analysis of the pros and cons of each option, we will decide on a practical shooting mechanism. (Sarah Ilyas)