

# **DESIGN PROJECT PROPOSAL**

## **ANTENNA ARRAY FOR AUTOMOTIVE COLLISION AVOIDANCE**

by

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### **ABSTRACT**

The following document proposes an antenna array for automotive collision avoidance for the capstone project of Tim Carroll and Mohamed Wagiealla. First, a brief history and description of current collision avoidance systems is included. Then, our plan for the project is discussed. Finally, a timeline of our proposed project is included.

### **INTRODUCTION**

A collision avoidance system is a system that detects potential obstacles in the path of a vehicle and alerts the user in some fashion. A collision avoidance system for an automobile, then, would transmit a signal and receive it if this signal is reflected from a potential obstacle. To transmit and receive the warning signal, an antenna array is advantageous. An antenna array allows high directivity, narrow beams, low side lobes, steerable beams, and shaped antenna patterns [1].

The need for collision avoidance systems became apparent in the 1950s, particularly when a collision between two airliners occurred over the Grand Canyon on June 30, 1956 [2]. Since then, collision avoidance systems for aircraft have been investigated and implemented, with the current standard being the Traffic Alert and Collision Avoidance System, or TCAS [2]. In 1995, development of collision avoidance for automobiles began with the Automotive Collision Avoidance System (ACAS) program [3]. The ACAS system was designed to warn drivers of obstacles in the front, sides, and rear of the automobile [3].

### **AUTOMOTIVE COLLISION AVOIDANCE SYSTEM**

The proposed automotive collision avoidance system project will consist of three major parts: selection and design of an individual radiating element, design of an array of radiating elements, and design of a power divider for the array of radiating elements (see Figure 1 on the following page).

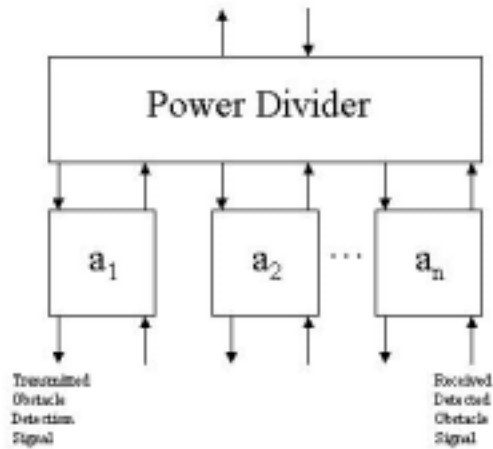


Figure 1  
Block Diagram of Automotive  
Collision Avoidance System

Specifically, this project will involve the design, testing, and fabrication of the aforementioned components. The radiating elements will be microstrip patch antennas. This makes the antennas light and have a low profile, which is important for system size and esthetics. The antenna array will be designed based on the number of elements needed, the amount of space needed between elements, the gain needed for the elements, and the beamwidth needed for each element. The power divider will be designed based on the amount of power the antenna array needs, matching the impedance of the antenna array, and obtaining a low VSWR for the antenna array.

## SYSTEM SPECIFICATIONS

Specifications for the current collision avoidance system have not been developed yet. However, specifications for ACAS (see Figure 2) will be included in order to provide an accurate comparison to the specifications the collision avoidance system will have [3].

|                    |                   |
|--------------------|-------------------|
| Frequency          | 24.125 GHz        |
| Mainlobe Length    | 8-10 m            |
| Mainlobe Width     | 4.5 m             |
| Planar Antenna     |                   |
| Antenna Gain       | 7-9 dB            |
| Azimuth Beam Width | 24-26 degrees     |
| Azimuth Side Lobes | (-12) to (-22) dB |

Figure 2  
ACAS Specifications

A limiting factor for this project, however, is the frequency must be below 20 GHz, since that is as high as the spectrum analyzer in the RF Communication Lab will go.

### **COMPONENTS NEEDED**

1. Circuit Boards
2. Passive Components (such as connectors, resistors, capacitors, and/or inductors)

### **EQUIPMENT NEEDED**

1. HP-ESGD Signal generator
2. Network Analyzer
3. Spectrum Analyzer
4. Multimeters
5. Anechoic Chamber and Data Acquisition

### **SOFTWARE TOOLS NEEDED**

1. Personal Computer Aided Antenna Design (PCAAD)
2. HPADS

### **MEASUREMENTS**

1. Antenna Array
  - A. VSWR using Network Analyzer
  - B. Gain Measurements using Spectrum Analyzer
  - C. Radiation Patterns and Antenna Gain using Anechoic Chamber and Data Acquisition Software
2. Power Divider
  - A. S-parameters (particularly  $S_{21}$ ) using Network Analyzer

B. VSWR using Network Analyzer

**FABRICATION FACILITIES NEEDED**

1. RF Fabrication Laboratory
2. RF Communication Laboratory

**REPORT OUTLINE**

1. Abstract and Introduction
2. Array Design
  - A. Radiating Elements
    - i. Selection
    - ii. Design
    - iii. Fabrication
    - iv. Testing
  - B. Power Divider
    - i. Design
    - ii. Fabrication
    - iii. Testing
3. Array Integration
4. Array Fabrication
5. Array Measurements
6. Conclusion
7. References
8. Appendices

## SCHEDULE

| TASK/MONTH         | 1/24/2002<br>to 02/07/02 | 2/14/2002<br>to 02/28/02 | 3/7/2002<br>to 03/21/02 | 3/28/2002<br>to 04/11/02 |
|--------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| Radiating Element  |                          |                          |                         |                          |
| design             |                          |                          |                         |                          |
| fabrication        |                          |                          |                         |                          |
| testing            |                          |                          |                         |                          |
| Antenna Array      |                          |                          |                         |                          |
| design             |                          |                          |                         |                          |
| fabrication        |                          |                          |                         |                          |
| testing            |                          |                          |                         |                          |
| Power Divider      |                          |                          |                         |                          |
| design             |                          |                          |                         |                          |
| fabrication        |                          |                          |                         |                          |
| testing            |                          |                          |                         |                          |
| System Integration |                          |                          |                         |                          |
| testing            |                          |                          |                         |                          |
| Presentation       |                          |                          |                         |                          |

## REFERENCES

- [1] F. Ulaby, "Fundamentals of Applied Electromagnetics", Prentice-Hall. 1999.
- [2] "Traffic Alert and Collision Avoidance System." <http://www.caasd.org/proj/tcas/> (1 Dec. 2001).
- [3] "ACAS Program Final Report -- May 10, 1998"  
<http://www.nhtsa.dot.gov/people/injury/research/pub/ACAS/TOC.htm> (1 Dec. 2001).