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**DEGREE:** Philosophiae Doctor  
**FACULTY:** Faculty of Mathematics and Natural Sciences  
**DEPARTMENT:** Department of Informatics  
**AREA OF EXPERTISE:** 3D printed antennas and microwave devices  
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**DISSERTATION TITLE:**  
*Exploring New Design Possibilities of Broadband, Passive Microwave Systems with Additive Manufacturing*

Additive manufacturing (ADM) can be used to fabricate functional RF and microwave devices. Due to its versatility it can also be used to improve the RF performance and provide easy integration in 3D printed systems.

The fast development and miniaturization of software defined digital hardware increase the demand for compact radio frequency (RF) and microwave passive, front-end components. To suit those requirements ADM is a promising fabrication method. ADM not only simplifies the complexity of fabrication at a lower cost and weight, but also offers the ability to modify, re-print, and test parts on the fly; devices can be customized for a particular application and/or space, and easily integrated. Moreover, the versatility of ADM to manipulate raw materials at a substructure level translates into the potential to improve device performance.

This thesis researches the feasibility of using ADM to fabricate complex systems and structures. Rotman lens, for example, is a complex, true time-delay system, able to produce multiple beams without changing the orientation of the antenna. In this research, a 6 to 18GHz Rotman lens able to scan +/- 30° is demonstrated. In addition, 3D printing is used to engineer gradient index (GRIN) dielectric structures. These GRIN structures are loaded into horn antennas to reduce the side lobe levels (SLLs), producing radially symmetrical radiation patterns, while maintaining good impedance match and high radiation efficiency over more than an octave bandwidth.

This work demonstrates that ADM produces accurate, repeatable and functional complex microwave devices and at the same time improves RF performance at no additional cost and at a fraction of the weight. Besides, it is verified that these 3D printed devices are well suited for high power applications. This thesis paves the way for new design possibilities that can fulfill the ever changing demands of emerging systems.