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Software Defined Radio Implementation of an Interferometry Capable Radio Telescope Using Low-cost DVB-T Receivers

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Recent technological advancements have made radio astronomy accessible to amateur astronomers. With growing developments in the Software Defined Radio (SDR) technology, accessibility of capable radio equipment has increased due to lower costs. Whereas, the trend of moving hardware functions to software brought by SDR has improved the flexibility.

Radio interferometry is a technique very commonly used in radio astronomy as it allows for higher angular resolution than possible with a single antenna [2]. The requirement for a radio interferometry application is to measure the path delay precisely between the two signals caused by the position of the source which is achieved using cross correlating the two signals. The aim of this investigation is to find an affordable and easy solution as a radio interferometer meant for radio astronomy enthusiasts and students.

In 2010 it was discovered that mass-produced and low cost Realtek RTL2832U based Digital Video Broadcast-Terrestrial (DVB-T) receivers were actually general-purpose SDRs [1]. These SDRs became an attractive choice for amateur and educational use due to their flexibility and affordability and became known as RTL-SDRs named after the Realtek RTL2832u chip they were based on. Previous investigations have found that RTL-SDRs can be modified into a coherent receiver system, and have been successfully applied in passive-radar systems [3, 4].

A two-channel coherent receiver was made by Darade P. for this project. The fabrication was fairly simple and it required the use of two RTL-SDRs. One RTL-SDR had its surface mount crystal removed and it was fed the clock signal from the crystal of the other RTL-SDR using a piece of wire twisted together with a ground wire. The SDR flowgraph for performing cross correlation test was made in GNU Radio. The receivers need to be synchronized after every continuous run, to achieve synchronisation most of the commercial solutions use switchable common noise source fed to every channel which is switched on during synchronisation. However due to budget and simplicity, synchronization was achieved simply by feeding both the channels with a single copper wire antenna. In the GNU Radio flowchart, the path length error caused by the boot up time of the receivers and Universal Serial Bus (USB) can be compensated by shifting the samples of one of the receivers.

A basic two antenna interferometry setup was made using two antennas, Low Noise Amplifiers (LNA) for each channel and the coherent receiver. The setup could perform basic Direction of Arrival (DoA) estimation. It could also observe sources in the sky.

The results displayed the viability of using RTL-SDR based receiver systems for educational and amateur applications in radio astronomy. The receiver offers a significant cost reduction which could help make the field of radio astronomy more accessible to interested people.

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