**Intellitune**

**1. Problem Statement**

**1.1 Historical Introduction**

Ham radio is a hobby where operators communicate to each other from different parts of the world, transmitting directly from one radio to another. Additionally, ham radios can be utilized in emergency situations where telephone lines and internet may be unavailable. In 1894, just six years after electromagnetic waves were proven to exist by Heinrich Hertz, Guglielmo Marconi produced the first successful radio transmission, opening the door for amateur, or ham, radio operation [1].

Even before the first radio transmission, circuits dealt with the problem of reaching max efficiency due to mismatched impedance. In 1893, Nikola Tesla was the first person to publicly feature a wireless system with similar tuning concepts as used today. Soon after, many different circuit designs were developed based on Tesla’s [2][3]. Some of the early tuning circuits that implemented a variable inductor and variable capacitor are still the basis of modern antenna tuning units (ATUs).

Crude amateur radio methods such as chicken wire, headphones, and spark transistors led to interference and power transmission loss [1]. While ham radio technology progressed away from those earlier methods, power loss in transmission remained. A need for an impedance matching circuit within the system was necessary for efficiency. More modern tuning started using a manual tuning unit which utilized variable capacitors and inductors to compensate for power loss due to mismatched system impedance [1]. Manual tuning was standard until MFJ introduced an automatic tuning unit, which the Intellitune will improve upon.

An antenna’s impedance is dependent upon many factors, such as its length, height above ground, and operating frequency. In addition, the feed line to the antenna has an impedance which depends on the construction of the cable [4]. The feed line acts as an impedance transformer such that the impedance seen by the transmitter is the load. Since most amateur radio transmitters are designed to power an impedance of 50 ohms, some additional circuitry is needed between the transmitter and the antenna to regulate this impedance. Antenna tuning units solve this problem, regulating the impedance seen by the transmitter to 50 ohms over the range of frequencies used. By doing this, the transmitter is able to operate more efficiently as the amount of reflected power is greatly reduced or eliminated.

Using those same base concepts established in 1893 and 1897, the Intellitune will bring a new automatic tuning unit to the ham radio community. This automatic tuning unit will bring a more economical and reliable product to operators in hope to notch its own contributions to the long history of tuning and ham radios.

**1.2 Market and Competitive Product Analysis**

In the United States, the amateur radio community is large and ever growing. The FCC Universal Licensing System database reports 821,255 active ham radio licenses [5]. With this large of a community, a market is present that the autotuner can satisfy. Palstar’s AT4K antenna tuner is a comparable product priced at $899 and rated up to 2500 Watts [6]. The Intellitune shall feature that same power rating, all while providing an automatic tuning experience.

The LDG IT-100 is an automatic ATU that is capable of matching the impedance for several different rigs. The IT-100 features a power rating of 100 watts with a tuning time between 0.1 and 6 seconds. In addition, the LDG also utilizes memory recall for frequencies previously tuned to reduce tuning time [7]. The Intellitune will employ a similar memory recall function and comparable tuning times, but is rated for a much higher power output.

The Intellitune builds upon the MFJ-9982 manual tuner, which employs a variable capacitor and inductor, as well as the MFJ-998 auto-tuner, which implements discrete reactive components with relays for precise impedance matching [8]. The Intellitune features several components from both designs and optimizes them in a new and improved model.

**1.3 Concise Problem Statement**

Ham radios have antennas that must be tuned before the system can be used. For years, radio users have been tasked with matching the antenna impedance, or tuning, by turning knobs on an ATU to match impedance and operate the radio transmitter at peak efficiency. The nature of this process leaves much room for human error and requires time to find the correct setting. Consequently, after tuning by hand, the optimal setting may not have been reached by the user. The Intellitune will solve this problem by matching the impedance of the antenna at the set frequency automatically, allowing for maximum power transmission and an improved user experience.

In the past, some antenna tuners have been manufactured to simplify the tuning process, but this new, completely automatic tuner shall take this a step further. The Intellitune will read in the standing wave ratio of the network via a Voltage Standing Wave Ratio (VSWR) meter, which describes the amount of power reflected by the antenna, and use this value to determine what adjustments need to be made to the tuner. Then, the Intellitune will alter its tuning components until the antenna impedance has been matched according to the reading from the VSWR meter. The Intellitune will also have the ability to save the tuning parameters for various frequencies, enabling faster tuning the next time the specific frequency is selected. As a result, tuning time will be diminished more. In similar ATU designs a greater amount of relays are used and have to be replaced periodically. The Intellitune will implement fewer relays, resulting in less tuner unit service due to the more reliable design.

**1.4 Implications of Success**

Upon successful completion of the Intellitune automatic tuner, it will be a more efficient, reliable, and effective alternative to automatic tuners currently on the market. The Intellitune will capture an audience of consumers who are looking for an antenna tuner that is capable of handling high loads that the other automatic tuners have been incapable of handling. Radio operators that were satisfied with the MFJ-998 model but are now in need of a higher rated automatic tuner will leap for the Intellitune. Alternatively, operators looking to ease the tuning process but maintain the performance characteristics of the MFJ-9982 will seek the Intellitune.

The Intellitune will certainly improve the overall function of the ham radio. Its higher power rating will enable users to communicate with other operators they once could not. Additionally, it could attract more interest in ham radio with the solution of simple automatic tuning. With the continuous rise in ham radio popularity, the Intellitune will ease operation and make the radio experience more enjoyable for radio hobbyists. Ham radio operators will see a new product with effective features at a competitive price which will give them confidence to make the leap to that next piece of equipment.

**References**

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