SECURE RADIO TELEMETRY AND DATA ACQUISITION USING WIRELESS DATA COMMUNICATION SYSTEM WITH PORTABLE UHF TRANSCEIVERS

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ABSTRACT

Telemetry systems are an important part of communication and control technologies in today's industry. One of its main tasks is to acquire or collect data at remote location and send the data to a location either through cables or radio waves where the data can be received for evaluation and analysis. The main objective of this research is to design and develop a secure telemetry system that uses radio waves as a communication media to relay information for monitoring environmental conditions. The system comprises of two main subsystems; they are remote telemetry station (RTS) as a data collection center and base telemetry station (BTS) as a data evaluation center. The RTS comprises of a personal computer equipped with data acquisition system, voice band modem, analog transducers for measuring temperature, humidity and atmospheric pressure, and a portable UHF transceiver. On the other hand, BTS comprises of a personal computer equipped with data acquisition software, voice band modem and a portable UHF transceiver. A software programming based on LabVIEW was developed for data processing and presentation at both RTS and BTS. The data collected at RTS site are encrypted prior to transmission to the BTS by employing the One Time Pad (OTP) and Caesar Cipher algorithms. These algorithms are chosen because they are suitable for low bit rate data. The modems use frequency shift keying (FSK) modulation to convert digital signal into analog and vice versa. The modulated signal is transmitted from RTS to BTS by using the UHF transceiver with frequency modulation (FM) at 477.1 MHz as the carrier frequency. The data communication protocol used is serial asynchronous via RS232 port. The telemetry system is successfully designed and developed. The performance of the telemetry system is successfully evaluated in the laboratory and field for 1 km range. The results of the evaluation show that there is no bit error during 300 and 600 bps data rates and the average SNR is 28.96 dBm. The accuracy of data transmission is determined to be at 99.99%.

1. INTRODUCTION

Radio telemetry is a technology concerned with the transmission of measured physical quantities such as temperature, humidity, pressure, etc. from a remote location to a base station using radio waves (RF). By definition, telemetry means measurement at a distance. This technology has wide areas of applications in the military, industry, medical and biological sciences. Radio telemetry is also used in aircraft and missile flight tests, monitoring environmental conditions, heartbeat and blood pressure of humans and animals' behaviors.

The objective of this research is to experimentally establish a telemetry system for monitoring ambient temperature, humidity and atmospheric pressure using RF as a communication medium. The data communication protocol used in the system is serial and asynchronous transmission via RS232 communication port with frequency shift keying (FSK) modulation for digital to analog conversion. Frequency modulation (FM) is used for RF transmission to the receiving station. The transmission band for the RF is in the UHF band.

A literature review of the previous and present telemetry systems are described in section II. The primary elements of the telemetry system that includes data acquisition system, modem and transceiver (transmitter and receiver) are also explained. The technique for data communication protocol and modulation are also included in the chapter. Cryptography is a technique concerned with data manipulation, is also highlighted. Bit error rate test (BERT) and signal and noise measurement for the system evaluation are also described.

Consequently, in section 3, detail descriptions of the experimental telemetry system configuration are given. The major components of the transmitting and receiving telemetry system are also explained. LabVIEW, which is the Graphical programming software used in the system, is introduced in this section.

In section 4, operating descriptions of the instrumentation used during the experimental work such as IFR 2398 Spectrum Analyzer, Topward Function Generator, Digital Storage Oscilloscope, Virtual Instrument: Bench Top Spectrum Analyzer, and Data Tester are included. The IFR Spectrum Analyzer is used to measure the RF carrier frequency, the channel power and noise levels. Topward function generator is used to simulate the FSK analog signal of the telemetry system. The digital oscilloscope is utilized to measure the frequency of modulating signals of the telemetry system. The Virtual Bench Top spectrum analyzer is employed to measure the noise characteristics of modem used in the telemetry system and to measure low frequency spectrum. Data Tester is used to perform bit error rate (BER) test on the telemetry system.

The research that is conducted and performed experimentally, involved in the design and development of the telemetry software and hardware system. Upon completion of the telemetry system development and integration, it is required to undergo system evaluation test in the laboratory as well as in the field condition. At the end of the chapter, the experimental methods and procedures such as signal and noise measurement, BER test and data transmission test are thoroughly described.