AMATEUR RADIO BASED WEATHER STATION

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Dedicated to my parents, family and loved one.

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ABSTRACT

Weather is an important factor in daily activities and economic sectors, such as tourism and agriculture. As easy as it may seems to be to get a weather report from mass media, it is difficult to get local weather status at a specific area, which may be differed from other places at a few kilometers away. In rural areas, where telecommunication and transportation are hard to establish, local weather report is even harder to come by. This project presents an alternative using weather station that based on amateur radio as its communication tool. In this final year project report, a detailed description about project concept and technical aspect is given. Based on the methodology as mentioned in the report, the outcome of the project is described. At the end of this report, recommendations are made to further improve the project.

ABSTRAK

Cuaca merupakan faktor yang penting dalam aktiviti seharian dan sektor ekonomi, seperti pelancongan dan pertanian. Walaupun laporan cuaca senang diperoleh dari media massa, namun cuaca tempatan di suatu kawasan tertentu susah ditentukan, lebih-lebih lagi terdapat perbezaan cuaca tempatan berbanding dengan kawasan lain dalam jarak beberapa kilometer sahaja. Di kawasan pedalaman, cuaca tempatan lebih susah diperoleh kerana kekurangan telekomunikasi dan pengangkutan. Projek ini memberi satu alternatif dengan menggunakan stesen cuaca berdasarkan radio amatur sebagai alat komunikasi. Penjelasan secara terperinci mengenai konsep projek dan aspek teknikal telah diberi dalam laporan projek tahun akhir ini. Berdasarkan kaedah-kaedah yang tersenarai dalam laporan, keputusan yang diperoleh melalui projek ini telah dipersembahkan. Akhir sekali, beberapa cadangan telah dikemukakan untuk menjadikan projek ini lebih baik.

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A/D	-	Analog/Digital
AC	-	Alternate current
AMSAT	-	Amateur Satellite
APRS	-	Automatic Positioning Reporting System
APRS-IS	-	Automatic Positioning Reporting System – Internet Service
ASCII	-	American Standard Code for Information Interchange
AX.25	-	Amateur X.25
BBS	-	Bulletin Board Systems
BLDC	-	Brushless Direct Current
CPU	-	Central Processing Unit
CRC	-	Cyclic Redundancy Check
CSMA	-	Carrier Sense Multiple Access
DC	-	Direct Current
DCE	-	Data Circuit-Terminating Equipment
EEPROM	-	Electrically Erasable Programmable Read Only Memory
FM	-	Frequency Modulation
GPR	-	General Purpose Registers
GPS	-	Global Positioning System
HF	-	High Frequency
HMS	-	Hour, Minute, Second

I/O	-	Input/Output
IC	-	Integrated Circuit
LCD	-	Liquid crystal display
LED	-	Light Emitting Diode
mph	-	miles per hour
PBP	-	PicBasic Pro Compiler
PC	-	Personal computer
PCB	-	Printed Circuit Board
PIC	-	Peripheral Interface Controller
PTT	-	Push to talk
RAM	-	Random Access Memory
RF	-	Radio frequency
RISC	-	Reduced Instruction Set Computer
SFR	-	Special Function Registers
SHF	-	Super High Frequency
SMT	-	Surface-mountable
TNC	-	Terminal Node Controller
TTL	-	Transistor-transistor Logic
UHF	-	Ultra High Frequency
VHF	-	Very High Frequency
WDT	-	Watchdog Timer

Chapter 1

Introduction

1.1 Microclimate

A microclimate or local weather is a weather pattern that is localized in a small area. It is different in some significant way from weather of nearby areas. The weather variables in a microclimate can consist of temperature, humidity, rainfall, wind, or any combination of these [1]. In short, it is the amalgam of many, slightly different microclimates that makes up the climate for a larger area [2].

Microclimates may be subtly different from one another due to the conditions prevailing over the area as a whole, such as atmospheric pressure or cloud cover. The most important factor that affects microclimates is the location of the area. Weather at upland areas is different from weather in urban areas or coastal areas. Therefore, microclimate can only be determined by a weather station at the site.

Better information about microclimates allows people to make better decisions:

1) When dangerous weather threatens life and property

2) In everyday planning (e.g. outdoor activities)

3) In normal economic activities that have some degrees of weather dependence, such as agriculture and tourism

1.2 Problems Identification

Telecommunication is a major problem in rural areas such as Belaga, due to limited infrastructure and resources. In these areas, Internet and telephone systems are hard to setup due to lack of transportation availability, geographical problems (e.g. at upland and forest areas) and limited population. These factors increase the installation and maintenance fees to establish communication with these areas, thus reducing the feasibility of the task [3].

Similar to other places, it is necessary to obtain local weather report in rural areas. Apart from determining weather condition in a particular area, the report is useful when it comes to natural disasters, such as heavy storm, flood and forest fire. Authorities concerned can alert nearby residents to evacuate to safer areas as soon as possible when emergency arises. Therefore, local weather needs to be monitored constantly [4].

However, as mentioned earlier, setting up effective telecommunication in rural areas is proven to be an arduous task. Weather data must be sent to a receiving station located further away, with easier access to infrastructure and facilities. Until now, weather officers have to travel to rural areas periodically to retrieve weather data from the weather station there, which is time-consuming and inefficient. Even if telephone lines are available, they are still limited and Internet connection is not fast enough to convey local weather data efficiently [4].

Furthermore, natural tourism venues, such as national parks and beaches depend on weather condition. For example, a trip to Bako National Park or Damai beach will be severely affected if rain occurred. Without knowing the particular weather condition, visitors may waste time if they find the weather unsuitable for trip along the way.

1.3 Project introduction

This project uses amateur radio in local weather reporting. It is achieved via *Automatic Positioning Reporting System (APRS*), which allows one to transmit digital data in packet form using amateur radio. Local weather data that consists of temperature, humidity and wind speed, is collected and transmitted to a receiving station at a distance apart. It does not need telephone lines or Internet access to operate.

1.4 Application and Recent Advancement

1.4.1 The Torrey Pines Gliderport, San Diego, California

Paragliding is an extreme “foot-launched” sport, which allows ones to enjoy a short flight along a ridge or a lengthy cross-country flight by using sailplane [5]

Paragliding is at the mercy of the weather. To make things worse, installing a weather station at the remote Torrey Pines Gliderport is difficult, since there is no commercial AC power source and the number of phone lines is also limited [5]

Richard Parry, W9IF set up an APRS weather station to provide communication from the gliderport to a local APRS network and ultimately to the Internet, where anyone in the world can monitor the weather conditions [5].

1.4.2 APRS-Internet Service (APRS-IS)

APRS-IS is a high speed backbone interconnection of local RF (radio frequency) APRS networks worldwide, using Internet as communication link. It provides a method for strategic communication through a tactical protocol, allowing messaging to occur between two stations on opposite sides of the world, without requiring the knowledge of specific paths. APRS-IS allows Internet-connected HAMS (amateur radio operators) to combine APRS data with other Internet services [6].

1.5 Objectives

1. To develop an APRS weather station that can capture weather data, such as temperature, humidity and wind speed
2. To develop an interface to connect the weather station to a TNC (Terminal Node Controller). The interface will convert the weather data into APRS format
3. To establish connection between the weather station and the receiving side via radio communication
4. To display weather data on the computer at the receiving side

1.6 Expected Outcomes

Figure 1.01 shows the block diagram of the amateur radio based weather station. The weather station must be able to measure weather conditions at a location, which are then broadcasted periodically through APRS transmitting station. In particular, the weather station measures temperature, relative humidity and wind speed. It also provides information about the time when the weather data is captured. All these data are displayed on the 1-line liquid crystal display (LCD).

Any calibration and data conversion is done at the data converter, so that the weather station itself only needs to return raw data. This allows the sensor calibrations to be fine-tuned, without having to modify the weather station firmware. The weather station periodically sends weather data to the data converter. When it gets the data, it processes it to turn raw measurements like voltages into the desired values. The data is

then converted to APRS format before it is periodically broadcasted using terminal node controller (TNC) and transceiver.

The packets are sent to the receiving station via radio link. Upon received, the receiving station decodes, checks for errors, and sends the received messages to a computer for display.