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TELEMETRY SYSTEM DESIGN ON PAYLOAD USING FLYMAPLE WITH ARM CORTEX-M3

Izzah F. Akmaliah[1)], Imam S. Nugroho[2)], Naniek Andiani[3)]

[1,3)] Teknik Informatika - Universitas Pancasila, Jagakarsa, South Jakarta, 12640, Indonesia
[2)] UKM R&D KMUP - Universitas Pancasila, Jagakarsa, South Jakarta, 12640, Indonesia

e-mail: rnd_up7@yahoo.com

Abstract

Telemetry system design at test rocket payload using the hardware Flymaple with microcontroller ARM Cortex-M3 as the Main Control Unit (MCU). This paper discussed about the design of a telemetry system that can measure temperature, humidity, pressure, acceleration, orientation, position and transmit images. The entire sensor is integrated on a payload with control system operators in the ground segment. Used in order to transmit data with a communication radio frequency 433 MHz and is controlled by a microcontroller ARM Cortex-M3. The test result of the dimensions, vibrations, rotations, designed system is able to transmit data and receive on the ground segment.

Keywords: ARM Cortex-M3, payload, MCU, algorithm.

INTRODUCTION

Measurement and data acquisition is an integral part of the instrumentation. Various kinds of data in the form of principal amount or amount of derivatives are measured and calculated so that the information in the form of data that can be utilized. Under the provisions of the measurements include measurements of temperature, humidity, pressure and others are included in the AWS program. In addition, the telemetry or remote measurements have also been done and done well. Communications media that have been used namely wireless frequency.

At this time telemetry is important, because with the telemetry the measuring process will be easier and can be done even in long distances. The important measurement of the parameters is condition with 1 km high. In this paper the design of measurement system parameters on the air using the payload rocket. For measurement can be done then the payload system is designed that is able to work well when launched in the rocket.

The rocket is an aerospace vehicle that is very important because of its ability to reach heights. Several factors are assumed as the cause of the disturbance on the payload on the minimization of such a shock and vibration. The use of telemetry has not been maximized in both dimensions, durability, stability is also the placement of antennas. In observance of the above factors then do the research, development, and instrumentation systems design payload rocket.

MATERIALS AND METHOD

MATERIALS

1. Transmitter

Transmitter is a device used to convert changes in sensing element of a sensor that can be translated by the signal controller. The material used in the transmitter is Rocket Payload, in which there were functioning sensors to measure temperature, humidity, pressure, wind direction, acceleration, and position.

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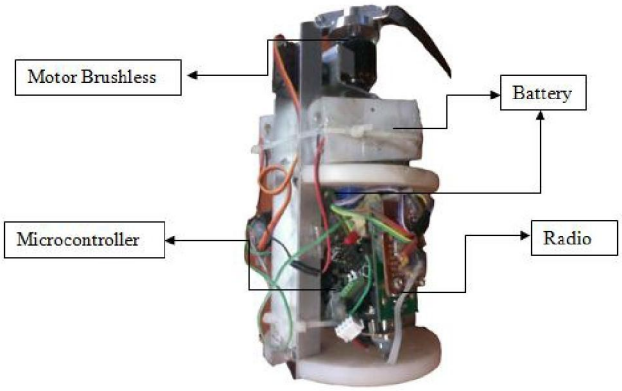

Figure 1. Payload

2. Receiver

Receiver is device that is used to receive the signal transmitted by the transmitter. Ground Segment is part of the rocket payload whose function is to receive digital data signals transmitted by the rocket payload.

Figure 2. Ground Segment

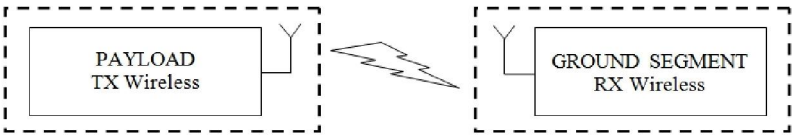

Figure 3. Block Design Of TX and RX

METHOD

1. Modulation

Digital modulation is the process of varying the characteristics and properties of the carrier wave (carrier) such that the form of the result (modulated carrier) has the characteristics of the bits (0 or 1) it contains. Means to observe the modulated carrier, we can determine the order of the bit with clock (timing, synchronization). Through the process of digital modulation signals digitally every level can be transmitted to the receiver well. This can be used for delivery of physical transmission media (metal or optical) or non-physical (radio waves). Basically a digital modulation system known 3 namely:

a. Amplitude Shift Keying (ASK)

Signal transmission through frequency shift, is a method by varying the modulation amplitude. In the process of the emergence of frequency modulation of the carrier wave depends on the presence or absence of digital information signal. ASK method is only beneficial when used for short distance relationships only.

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b. Frequency Shift Keying (FSK)
Signal transmission through frequency shift. This method is a form of modulation that allows modulating wave shifts the output frequency of the carrier wave. This shift occurred between the prices that have been previously determined by the output wave has no discontinuous phase. In the process of this magnitude modulation frequency of the carrier wave varies in accordance with changes in the presence or absence of digital information signal. In this process the carrier wave is shifted up and down to obtain the bit 1 and bit 0.

c. Phase Shift Keying (PSK)
Signal transmission through the phase shift. This method is a form that allows the phase modulation phase modulation function modulated wave between discrete values that have been set previously. In this phase of the modulation frequency of the carrier wave varies in accordance with changes in the status of the digital information signal. Phase angle must have a reference to the transmitter and receiver. As a result much needed stability at the receiver frequency.

2. Kinds Of Communication

a. Simplex
Simplex is a kind of one-way communication, where the direction information from the sender to the recipient only and can not be otherwise.

Figure 4. Simplex

b. Half duplex
Half duplex is a type of two-way communication, but the two communicating parties is not sending information at the same time, but had to take turns.

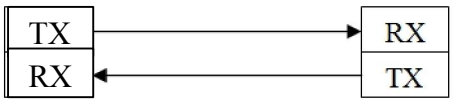

Figure 5. Half Duplex

c. Full duplex
Full duplex is a type of two-way communication, where each user can perform the delivery or receipt of information at the same time.

Figure 6. Full Duplex

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RESULTS AND DISCUSSION

ALGORITHM

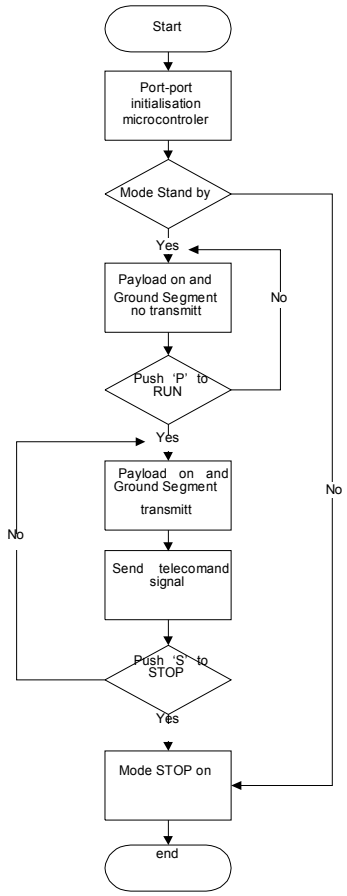

Figure 6. Algorithm Telemetry Payload

PAYLOAD TESTING

Testing of the payload design, includes 3 kinds of testing, each test is conducted to ensure that the payload can function properly as expected. The following is a kind of test:

A. Payload Testing on Test Equipment

Testing instrument payload using a form of meteorological sensors Flymaple ARM cortex-m3 and the form of sensors and operating systems telecommand. Payload there are three stages of testing before the rocket that carries the payload was launched with telecomMand operations, namely:

1. Test G-Shock : Where payload in durability tests with test tool that scales G-Shock 65 g. Scale testing is already equivalent to a common scale tests conducted on the rocket LAPAN.
2. G-Force Test : Test G-Force on the radio to 40 g.
3. Vibration Test : vibration test up to 40 g.

Each test telecommand operations are always on the run mode, for telecommand operations in accordance with the rules of the contest committee rocket load test (RUM) payload from LAPAN.

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B. Payload Testing

Output data payload in ground segment

Suhu = 58.1 C	Tekanan = 49.8 Kpa	Gravity = 4.4 G	RH = 63
Suhu = 57.6 C	Tekanan = 50.3 Kpa	Gravity = 4.5 G	RH = 53
Suhu = 58.1 C	Tekanan = 50.8 Kpa	Gravity = 4.5 G	RH = 55
Suhu = 57.6 C	Tekanan = 48.8 Kpa	Gravity = 4.4 G	RH = 75
Suhu = 58.1 C	Tekanan = 50.3 Kpa	Gravity = 4.4 G	RH = 55
Suhu = 59.6 C	Tekanan = 52.3 Kpa	Gravity = 4.5 G	RH = 55
Suhu = 58.6 C	Tekanan = 50.8 Kpa	Gravity = 4.4 G	RH = 65
Suhu = 58.6 C	Tekanan = 51.3 Kpa	Gravity = 4.5 G	RH = 55
Suhu = 60.1 C	Tekanan = 52.7 Kpa	Gravity = 4.5 G	RH = 55
Suhu = 61.0 C	Tekanan = 53.7 Kpa	Gravity = 4.6 G	RH = 25
Suhu = 44.2 C	Tekanan = 59.5 Kpa	Gravity = 2.7 G	RH = 0
Suhu = 44.6 C	Tekanan = 59.3 Kpa	Gravity = 2.2 G	RH = 0
Suhu = 50.1 C	Tekanan = 57.2 Kpa	Gravity = 2.4	RH = 15
Suhu = 52.1 C	Tekanan = 53.7 Kpa	Gravity = 1.7 G	RH = 15
Suhu = 56.1 C	Tekanan = 53.8 Kpa	Gravity = 4.3 G	RH = 45
Suhu = 56.6 C	Tekanan = 52.3 Kpa	Gravity = 4.4 G	RH = 0
Suhu = 58.1	Tekanan = 53.3	Gravity = 4.5 G	RH = 55
Suhu = 57.6 C	Tekanan = 50.8 Kpa	Gravity = 4.4 G	RH = 35

Figure 7. Output Data

CONCLUSIONS

We have designed a prototype rocket payload using sensors in the form of pressure sensors (pressure). The payload is designed to have a timer that triggers a separation. With the separation, the measurement data can still be done when payload parachutes fall brought an umbrella.

Telemetry is used in the form of telecommand using UHF frequency bands of 433 MHz and FSK modem with 9600 bps data transfer rate. From the test can be summarized as follows:

1. Wireless propagation is not affected to the distance in the data transmission to ground stations. The design of the payload can work well and be able to transmit data in the form of sensor output voltage value and the value of air pressure.
2. Tolerance of sending data to ground station has an average rating of 3.75 mV

Link the conclusions to the goal of the study but avoid unqualified statements and conclusions not supported by your data.

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