Multi systems for switch-on the flare of TWM rocket

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Abstract. Indonesia has two seasons in one year, the rainy season and the dry season. During those two seasons, sometimes the Indonesian people get the problem of flood and dry condition. The modification of the weather by seeding cloud is expected to be able to solve those problems. There are some technologies that have been used to do cloud seeding, i.e. air plane and rocket. This paper focuses on the development of various systems to switch the flare of TWM rocket (technology weather modification) on. The method of this development was using the GPS module, timer system, and the FTS (flight termination system) as the information for the microcontroller to switch the flare on. Based on the result of the test, all systems were able to work but which one is working, first, depends on the rocket condition in the air.

1. Introduction

Indonesia is a big country in the form of archipelago and has more than ten thousand islands. Indonesia is located on the equator line with only two kinds of climate condition, i.e. rainy season and dry season. With this condition, Indonesia gets a lot of advantages such as for farming, fishing, and so on. But nowadays, Indonesia also gets some disadvantages of the climate change. The condition of world’s climate now is very different with 20 years ago due to the existing of a lot of the factories in the world. The smoke resulted from the activity of those factories is the biggest actor in causing the climate change in the world. The monitoring of the weather condition is very important to give good information for people. Every day the television news always gives information of the weather condition in particular cities. T. Nadu [1] researched about weather forecasting by using artificial intelligence. The forecast information helps in various fields such as agriculture, travel, pollution dispersal, communication, disaster management, etc. Actually there are some methods that can be used for weather forecasting [2][3].

The climate change is associated with the greenhouse effect. The greenhouse effect is produced from the radiation process that occurs in the atmospheric layer. The greenhouse effect can melt the ice in the north and south poles of the earth. The melting of the ice in the poles can increase the water level of the sea. Besides the greenhouse effect that the smallest change to land cover implicates the weather due to the urbanization activity; it caused an extreme change activity to take place then impacts urban climate condition [4]. Urbanization promotes the changes of land use and land cover, as had been studied by S. Aekbal et al. [5]. To observe the weather condition on the area, A. Omary and A. Wedyan [6] said that the climate modelling is based on:

1. Historical weather records.
2. Daily rainfall and max-min temperatures.
3. Rain and temperature parameters relative to time, location, and height.
4. Air temperature, relative humidity, soil moisture, soil temperature, etc.
The rainy season with hard rain can cause flooding in some cities in Indonesia. A big city like Jakarta, in February 2017 was flooded for more than two days. The flood is a big problem for the people who live in Jakarta. The people cannot do their daily activities freely, such as going to work, going to mall, etc. The people cannot stop the hard rain, but they still can do some weather modification. The old technology for weather modification is using the airplane for seeding the salt to the cloud. This technology needs a high cost because this process involves some stakeholders. Another problem of this technology is it is not easy to operate the airplane in bad weather condition.

Some of technology had been applied for weather modification, such as using the “combined use of double weather radar in weather modification” [7]. This technology focused on the feasibility of using the operating parameters extracted from interconnected Doppler weather radar’s PPI image to control X-band weather radar, and make RHI scanning. C. Fan [8] introduced the key technology for automatic monitoring of the weather modification operation. The key technology means that the data of the automatic detection about the weather modification is important for the standardized management of weather modification operation. The new technology which was developed by Pustekroket-LAPAN and Balai Penelitian Modifikasi Cuaca-BPPT was using the TWM rocket. This rocket brings a flare to be seeded on the cloud. There are some conditions that need to be paid attention to. The first condition is that the rocket body must be made from material which can be destroyed to be small parts after the seedling process. The second condition is that the payload system ought to be able to make a good decision based on the information acquired from a sensor to start the seeding. The first condition is still on the progress and the second condition is the one which is studied in this paper. There were no papers that studied the multisystem to switch the flare on, therefore this research focuses on it. The method of this research is using multisystem to switch the flare on in TWM rocket. The multisystem consists of GPS, timer system, and FTS to provide information to controller to make decision.

2. Sensor system
Sensor is equipment that can be used to detect some information from environment condition. There are two kinds of sensor, i.e. electric sensor and mechanical sensor. In this research, the experiment was done by using only the electric sensor, which are GPS sensor, timer system, and flight termination system.

2.1. GPS module
Global positioning system (GPS) is a module that can provide information about position in latitude and longitude, as well as altitude. GPS is connected to a network of GPS-satellites which send the details of the position from space to earth. A GPS receiver gets the signal from satellite, and then the processor on it will calculate the exact position, time and speed for GPS receiver.

The application of GPS can be divided into two, the first one is for civil and military application. For civilian application, there are many applications of GPS receiver, such as for monitoring car, hiking, traveling, and so on. For military application, GPS can be used as a guide for missile or rocket or UAV to attack the target [9]. Figure 1 shows the commercial GPS receiver from Parallax Inc.

![GPS receiver](image)
2.2. Timer system

Timer system can act as the sensor for starting cloud seeding since the timer system becomes the reference of the starting to switch on the flare. The timer can be made from hardware or software. The counter IC can be used as the timer from the hardware system. The timer system for the TMC rocket is built from software. Figure 2 shows the timer system for TMC rocket.

![Timer system diagram](image1.png)

**Figure 2.** Timer system.

The microcontroller ATmega8 has a property as a timer. The precision of the timer or the delay is in the range of millisecond. This following code is how to make timer or delay based on the software on ATmega8.

```plaintext
Dim A as byte
A = 10
Delay (A)
```

![Three-bit timer diagram](image2.png)

**Figure 3.** Three-bit timer.

The timer system also can be built from the hardware electronics. Figure 2 is a timer based on the D-latch IC. This timer is designed for 3-bit timer.

2.3. Flight termination system

FTS is a system for terminate the flight vehicle when the mission failed [10]. FTS had been developed and tested for TMC rocket in December 2015 in Garut, Jawa Barat. Figure 4 shows the diagram of FTS. FTS consists of two systems, the decoder and encoder. The encoder sends the sinus signal with several kinds of frequency. This frequency is decoded by the decoder of the TMC module.
The hardware of FTS system can be seen on the figure 5. The encoder produces multi-frequency and the decoder decoded it.

3. Combination of multisystem
The method of this research is a combination of some systems which can switch the flare on. The combination of multisystem for switching the flare of TMC rocket on is a new research in Pustekroket-LAPAN. This idea aims to protect if one of the switch systems of the flare fails.
Figure 6 shows the block diagram of multi systems for switching on the flare for cloud seeding. There are three kinds of system that can be used as a parameter for switching on the flare. This method is as simple as this: if the first system fails the second system will work, and so on. Thus, the sequence of the system as the first reference and so on can be seen on table 1.

Table 1. The sequence of the multisystem.

| No. | The system  | Sequence   |
|-----|-------------|------------|
| 1   | GPS module  | The first  |
| 2   | Timer System| The second |
| 3   | FTS         | The third  |

The altitude of the cloud which will be given the flare is commonly known. So the GPS module is the first parameter to switch on the flare. Microcontroller reads altitude data from GPS module and then makes decision to switch on the flare. The software will set the parameter altitude to compare altitude data from GPS. The second parameter is the timer system. The timer system also can be set depending on the requirement of how long the rocket launches. The third parameter is FTS. The programmer doesn’t need to set the parameter of the FTS. This system can be activated anytime, depends on the decision maker of the TMC rocket launching.

4. Result and discussion
The experiment of cloud seeding had been done by using an FTS system to switch on the flare. The switching on system of flare for rocket technology was also done by using a timer system.

Figure 7. TMC rocket before launched.

Figure 7 shows the TMC rocket before it was launched. The azimuth of the launcher is 130 and the elevation angle is 70 degrees. Before the TMC rocket launched, the weather condition must be taken into account because this rocket is small. This rocket can be launched for the wind speed of under 6 knots.
Figure 8. Before the cloud seeding.

Figure 9. After the cloud seeding.

Figure 8 shows the condition of the sky before the TMC rocket was launched. On the image we see only the cloud in the sky. Meanwhile figure 9 is the image after the TMC rocket has been launched. The evidence that the rocket has been launched is that we can see the circle in figure 8 and figure 9.

5. Conclusion and future works

This paper only shows the idea of combination system for switching on the flare of TMC rocket using the multisystem. The combination system consists of FTS, timer, and GPS. Each of the system for switching on the flare had been done in the real experiment for TMC rocket and had been launched at the rocket launcher center in Garut but they have not yet been combined together.

For the future research and experiment, this idea of combination system to switch on the flare on the TMC rocket can be done to guarantee that the flare will be on for weather modification process.

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References

[1] T.R.V. Anandharajan, G. A. Hariharan, K.K. Vignajeth, R. Jijendiran, Kushmita, ‘Weather monitoring using artificial intelligence’, 2nd International Conference on Computational Intelligence and Networks (CINE), pp. 106–111, 2016.
[2] A. R. Gurung, ‘Forecasting Weather System Using Artificial Neural Network (ANN): A Survey Paper’, International Journal of Latest Engineering Research and Applications (IJLERA), vol. 2, no. 10, pp. 42–50, 2017.
[3] A. C. Subhajini, ‘Application of Neural Networks in Weather Forecasting’, International Journal of Weather, Climate Change and Conservation Research, vol. 4, no. 1, pp. 8–18, 2018.
[4] S. A. Salleh, Z. A. Latif, A. Chan, K. I. Morris, M. C. G. Ooi, W. M. N. W. Mohd, ‘Weather Research Forecast (WRF) Modification of Land Surface Albedo Simulations for Urban Near Surface Temperature’, International Conference on Space Science and Communication (IconSpace), pp. 243–247, 2015.
[5] S. Aekbal, Z. Abd, W. Mohd, and N. Wan, ‘Factors Contributing to the Formation of an Urban Heat Island in Putrajaya, Malaysia’, Procedia - Soc. Behav. Sci., vol. 105, pp. 840–850, 2013.
[6] A. Omary, A. Wedyan, A. Zghoul, A. Banihani, I. Alsmadi, ‘An Interactive Predictive System for Weather Forecasting’, International Conference on Computer, Information and Telecommunication Systems (CITS), pp. 1–4, 2012.
[7] Z. Huang and Y. Liu, ‘Combined Use of Double Weather Radar in Weather Modification’, *Third International Symposium on Information Science and Engineering*, pp. 330–334, 2010.

[8] C. Fan, ‘Key Technology Discussion of Automatic Monitoring about the Weather Modification Operation’, pp. 0–3, 2009.

[9] H. Y. Irwanto, ‘Development of New Autonomous Controller for Auto Take Off System of High Speed UAV’, *J. Phys.: Conf. Ser. 962 012015* vol. I, pp. 1–7, 2018.

[10] E. D. Arisandi, ‘Multi Frekuensi Encoder Flight Termination System (Multi Frequency Encoder Flight Termination System)’, *Jurnal Teknologi Dirgantara*, vol. 13, no.1, pp. 87–94, 2015.

[11] http://forums.parallax.com, 2017, accessed on March 3, 2018.