AUTOMATIC RAIN GAUGE (ARG)

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ABSTRACT

The automatic rain gauge has been successfully developed by Meteorological, Climatological and Geophysical Agency (BMKG-Indonesia) engineerings, using microcontroller ATMega 128 completed by BASCOM and Labview Program. This instrument is called Automatic Rain Gauge - BMKG (ARG-BMKG). The intensity and duration of rainfall can be measured by this tool. The ARG-BMKG tools is integrated with GPRS-Getway communication for streaming data and one-way voice call (missed call) for additional rainfall data. The ARG-BMKG's system tool is equipped with alarm to give warning for five numbers of cellular phones automatically if the accumulation of rainfall are more than 50 mm. This existence of this instruments can substitute the conventional rain gauge observation system or the common rain stations in the BMKG-Indonesia.

It's hoped that the substitution of the common rain stations can generate more advantages included network, cost, and the simplicity of operation and accuracy data. This instruments will help observer who have not specific education in meteorology or climatology.

Keyword: ARG, rain gauges, ATMega 128, BMKG's engineering, microcontroller.

I. Introduction

Indonesia is an archipelago country with the total number islands are 17,508 islands in 1.919.440 km^2 total area. Indonesia consists of 30 percent of lands and 70 percent of the seas, with the population more than 242 millions peoples. Indonesia have two seasons, dry season and rainy season.

BMKG has an authority related to meteorology, climatology and Geophysics in Indonesia. We have 119 Meteorological Stations, 21 Climatological Stations, 1 Global Atmosphere Watch (GAW), 31 Geophysical Stations, 202 Automatic Weather Station (AWS), 79 Automatic Agroclimate Weather Station (AAWS), 104 Automatic Rain Gauge Stations (ARG), and more than 4.000 conventional rain stations. That's way we still need a lot of Automatic Rain Gauge (ARG) to covered all of Indonesian's area.

Engineering Automatic Rain Gauge (ARG-BMKG) has been conducted by Meteorological, Climatological and geophysical Agency since 2007 and continuous until present. Development succeeded is conducted are:

1. Up grading *wireless* communication using GPRS *getway* and web server. Previously, it was using *SMS getway* only.
2. An additional database server to accommodate realtime of engineering ARG-BMKG that has been mounted in a few locations in indonesia using online-GPRS communication.
3. A system power supply is replaced with the higher capacity to be able to back-up of ARG-BMKG longer at the moment when there is no sunshine. Previously, the power supply system was using 16-20WP solarcell completed with 17 AH dry battery.

II. Materials and Methods

The Physical design for ARG-BMKG for this year is not different to previously design, little improvement is in the value of the power capacity of battery and solarcell used. The Physical design of this instrument can be seen in figure 1.

Figure 1. Physical design of ARG-BMKG in Citeko

The power supply system design in ARG-BMKG can be seen in this diagram.

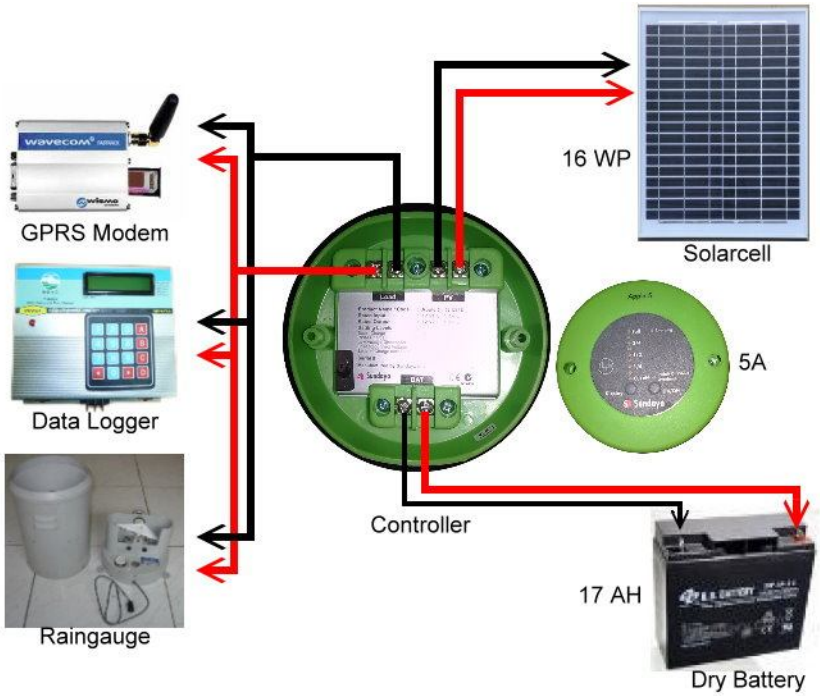


Figure 2. Diagram of power system design in ARG-BMKG

The power system design uses solarcell 16-20 WP and one Lithium ion dry battery 12 V with 17-18 AH capacity for backup power supply. A battery charging system is entirely sourced from solarcells utilizes solar energy during the day and the battery at the night.

Data logger is a major component of the ARG-BMKG which serves as a data saving of rainfall measurement and as main controller for entire system of the ARG-BMKG. The main functions performed by the data logger ARG-BMKG is as follows:

1. As the system of acquisition of rainfall measurements.
2. As a data storage of rainfall that is stored in memory card.
3. Set the delivery of data through RS232 to PC or via GPRS to the Web-Server and PC-Server in BMKG.

Design of acquisition program in the ARG–BMKG's data logger have many evolved and added the facilities, including:

1. The improvement of wireless communication wireless using GPRS Getway.
   Through GPRS Getway communication system, the spread of data will be more widely and easily admitted in the BMKG's central server. Requirement in GPRS Getway communication is needed at least one IP static. So that communication will fell on one address which remains; so required communication network rental. Address webserver that is used : rekayasa-bmkg.net with static IP: 203.29.26.147.
2. Additional storage sytem in PC Server.
   This PC Server is very necessary to serve as a data storage and permanent address in center of BMKG. PC Server is operated as a mirror from the web server, so data on the webserver will be on backup in PC server anytime.

A. Blok Diagram of ARG–BMKG's Data Logger

The ARG–BMKG Programming is based on a GPRS Gateway communication system. The outline of ARG–BMKG data logger mechanism design can be seen in figure 3.

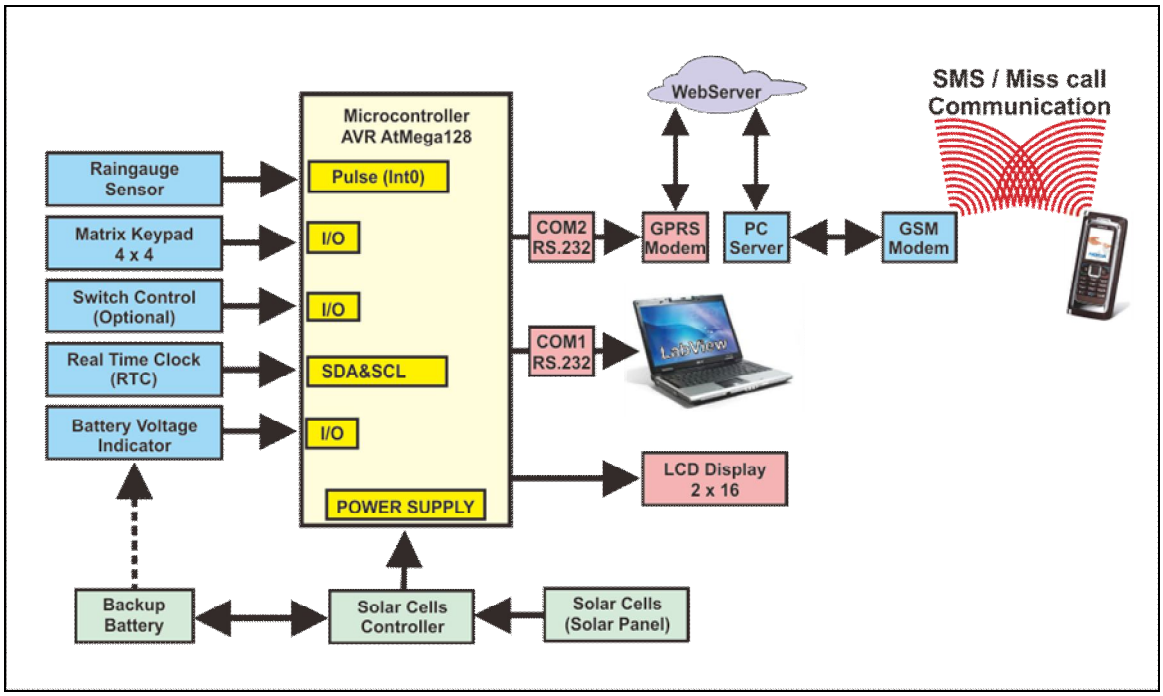


Figure 3. Blok diagram of ARG–BMKG's data logger design

Based on this figure, it can be seen that the input of the rain sensor comes to the data logger through pin ' Int0 ' which served as interrupt connection. The rainfall data sent to the PC and GPRS modem using IC MAX 232 to communicating via RS232 or RS485 serial port. Power supply for microcontroller comes from dry battery 12V-17AH which supplied from solarcell 20.WP. The time basis that used in microcontroller comes from the IC RTC uses SDA and SCL ports, while keypad using push bottom matrix keypad 4x4 on I/O ports. The display in the data logger using 2x16 character of LCD.

B. ARG-BMKG's Acquisition Program

ARG–BMKG acquisition program design was made to run "stands alone" system with upload this acquisition program to chip of microkontroler ATMEGA 128. The ARG–BMKG flowchart can be seen on figure 4.

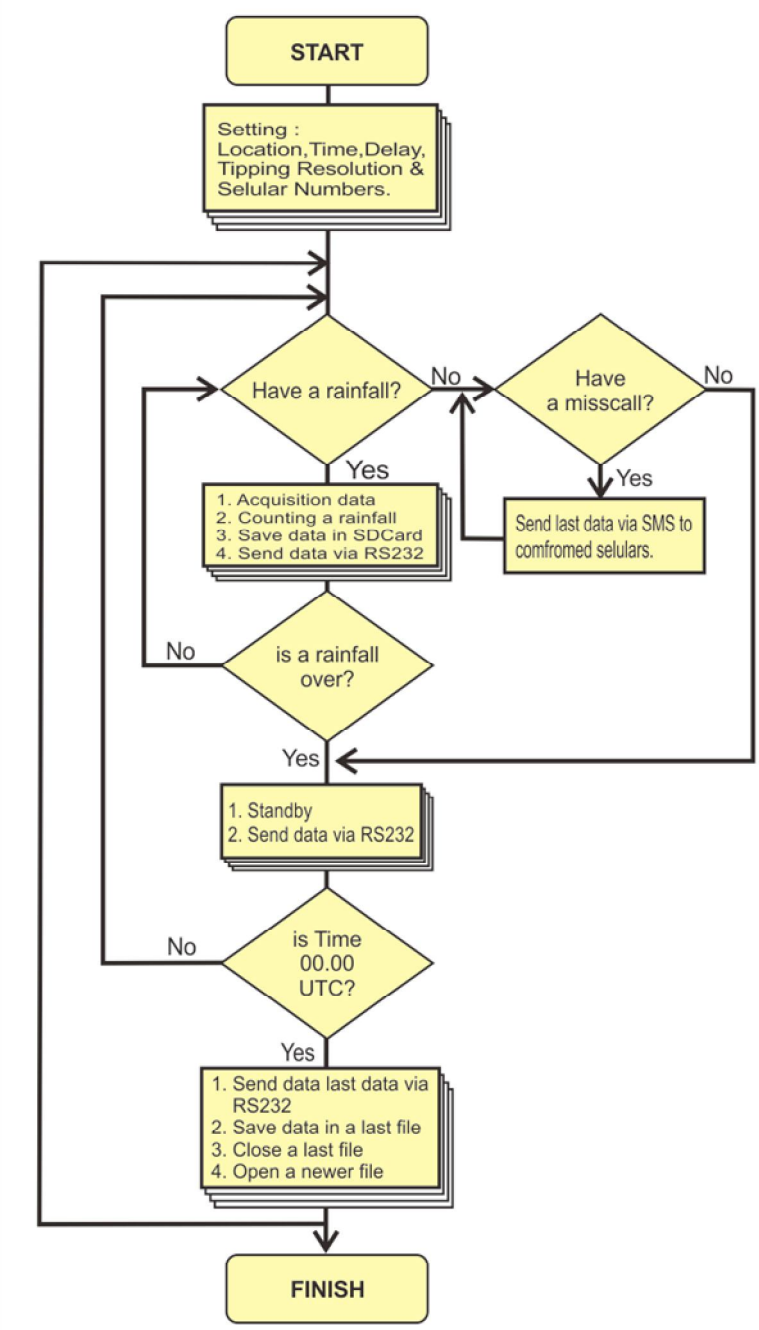


Figure 4. Flowchart of the data logger's acquisition programs

When the program start executed, it will do a time regulation on; date, time, tipping resolution, time delay and cellular telephone number that will be sent an SMS/alarm rainfall data. After the setting done, next signals from a rain sensor used as a trigger for microcontroller ATMEGA 128 to conduct a signal processing be a rainfall data. Then a rainfall data will be stored in SD Card storage, and every hour 00.00 UTC, the accumulated rainfall data will be sent to a few cellular telephone number that has been input before. If the rainfall more than 50 mm or the system accept a GSM / missed call,

ARG–BMKG automatically will send alarm message to a few numbers of these cellular phone automatically.

C. The ARG-BMKG's Data Logger

Data logger is a unit processing in ARG–BMKG system. In this data logger, the entire control and signal processing is done. The ARG–BMKG's data logger made simple, but a compact so easy to be operated and not complicate to the process of mounting. The PCB form of the ARG–BMKG's data logger can be seen in figure 5.

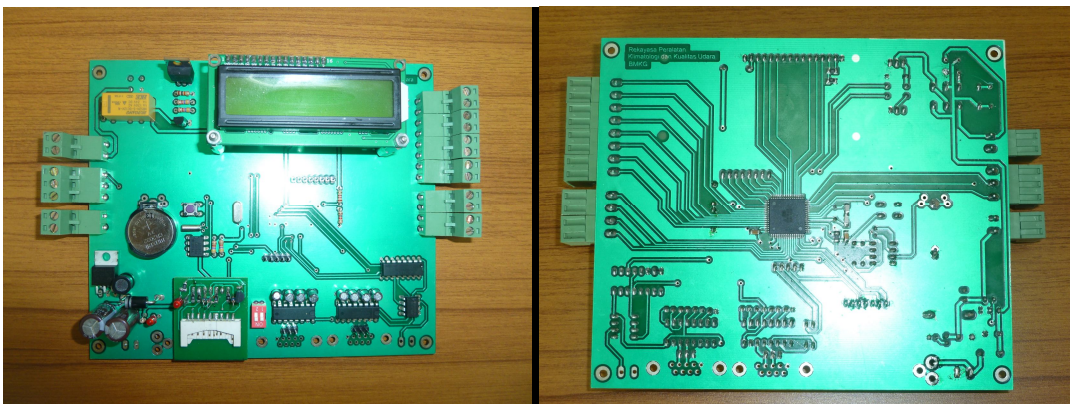
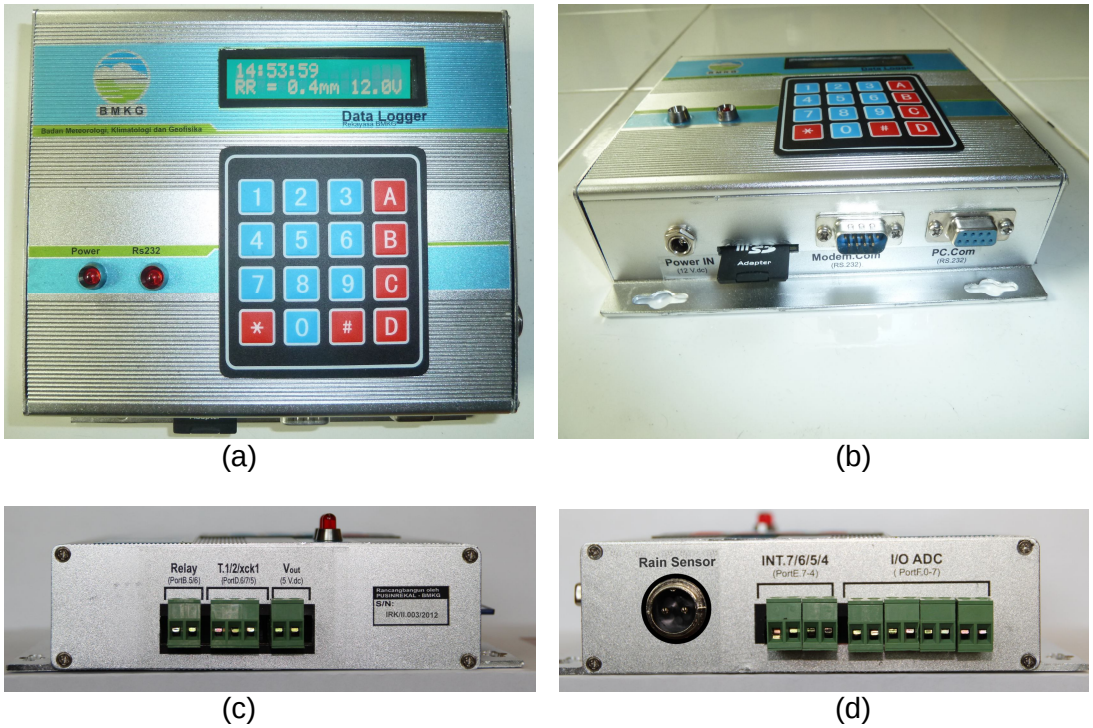


Figure 5. PCB layout of the ARG-BMKG's data logger

PCB used is the double layers with dimensions 10cm x 16cm. In this PCB, a whole components electronics is placed so that it becomes a unified system which is referred to as a data logger. The ARG-BMKG's data logger and the case can be seen in figure 6.



(a) (b)

(c) (d)

Figure 6. The ARG-BMKG's data logger, (a) Front side, (b) Lower side, (c) Left side, (d) Right side.

The ARG–BMKG's data logger physical form created based aluminium profile with dimensions 14cm x 16cm x 5cm. The front section data logger placed one LCD display with 16 characters - 2 lines, one matrix keypad 4 x 4 and two LED indicators. The bottom placed ports for connector, including: one connector to rain sensor, one connector to the

battery and two DB9 connector to transferring data by GSM modem or computer or notebook.

D. The ARG–BMKG's Application Program.

This program serves to display a real time data measurement and process download rainfall data from SD Card in a data logger. The ARG-BMKG's application programs made by Labview software version 8.5. The file Format is already formed the executable file (.exe). This installation process is easy and does not require additional programs. This application program of ARG BMKG can seen in figure 7.

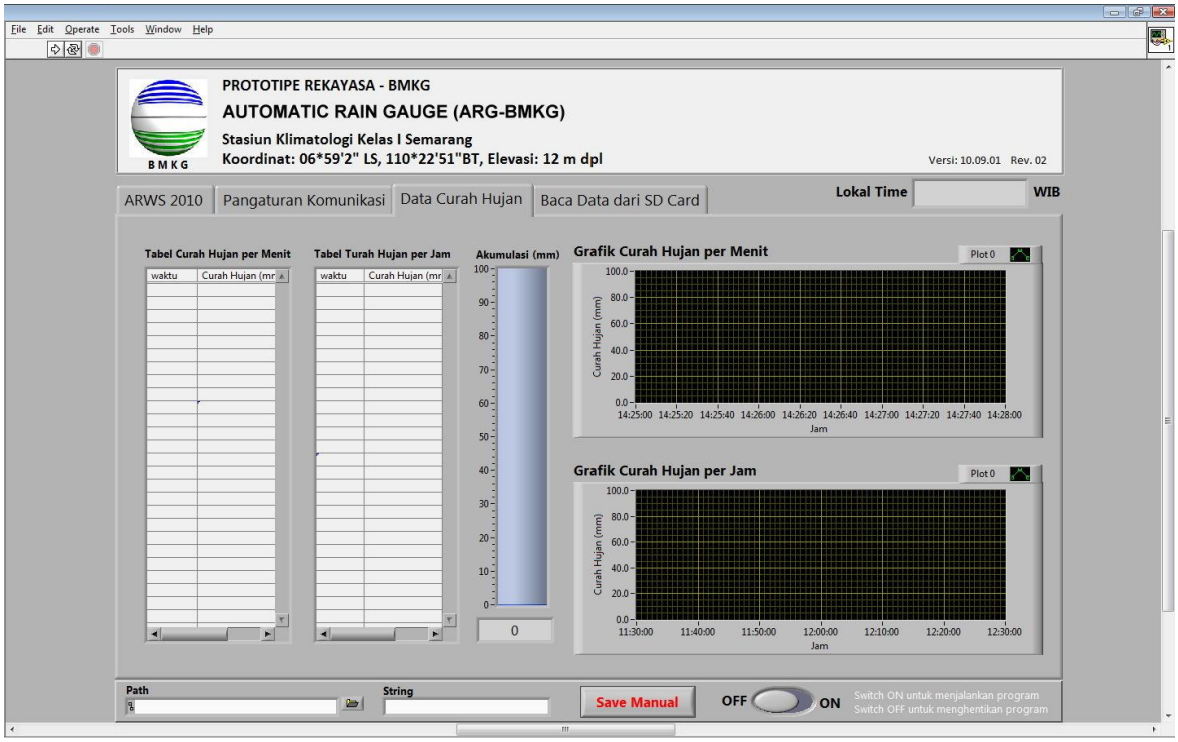


Figure 7. Display of the ARG-BMKG's application program on PC.

E. The ARG-BMKG's Data Communication Program based on GPRS Getway

Rainfall data resulting from the ARG–BMKG can be monitoried directly from a central office of BMKG. It is possible, if there is a wireless communication within ARG–BMKG system. GPRS wireless communication system is a selected to build a data collecting system from the all of ARG–BMKGs. GPRS system is a simple system, however proved to be quite reliable with strong support from the entire cellular provider in any city in Indonesia where the ARG-BMKG placed. GPRS Modem in use are product of sierra wireless, fastrack Xtend series. This GPRS Modem can be programmed so as to facilitate the setting up and operation.

IV. Results and Discussions

The rainfall measurement was done using rain gauge type tipping bucket from the Hydrological service-Australia. Resolution of rain gauge is 0.2 mm of rainfall. The acquisition data testing was conducted in a calibration laboratory of PUSINREKAL BMKG at Jalan Angkasa I No.2, Kemayoran, central part of Jakarta, Indonesia. This test performed with a rain gauge callibrator tool from Hanil.lab – South of Korea. The process of this laboratory testing can be seen in the figure 8, and the result of a data's rainfall from laboratory testing shown in table 1.

Figure 8. Process of acquisition testing in the PUSINREKAL-BMKG's calibration laboratory

The process of acquisition tested in the PUSINREKAL–BMKG's calibration laboratory done by comparing data of measurement from the ARG–BMKG and the standard calibrator from Hanil.lab-Korea. The calibrator having an ability to simulate the amount of rainfall with range 10-100 mm and variation of the intensity of rainfall between 10-250 mm/hours.The measurement of the simulation started by giving rainfall into a rain gauge with the variation of the intensity of rainfall about 40 mm/hours gradually to 250 mm/hours. This intensity variations of rainfall is very important to know the ability of the ARG-BMKG can measuring a variations of the intensity of light rain (drizzle) until heavy rain (showers).

Table 1. The ARG-BMKG's laboratory testing results

No	Intensity (mm/hr)	Standard (mm)	ARG-BMKG (mm)
1	40	8,8	8,8
2	60	8,8	8,8
3	80	5,2	5,2
4	100	8,8	8,8
5	120	7,4	7,4
6	140	6,8	6,8
7	160	7,2	7,2
8	180	7,8	7,8
9	200	9	9
10	250	8,8	8,8

Based on the testing result on a table 1, it is known that the ARG–BMKG's data acquisition for a rain gauge type tipping bucket can work well. With the variation rain intensity 40 mm/hours (light rain/drizzel) to 250 mm/hours (heavy rain/showers), without any error counting or double signal (cloning signal).

After performed a laboratory test, the next step is performed a field test. Location for field test was performed on climatological station at Semarang, Central part of Java. Field testing is done by comparing a data from 3 rain gauge installed on the same location and the same time. Data's used as a comparison is data from the ARG-BMKG, AWS-Vaisala and observatory rain gauge (conventional). The results of these trials were obtained as in the graph below.

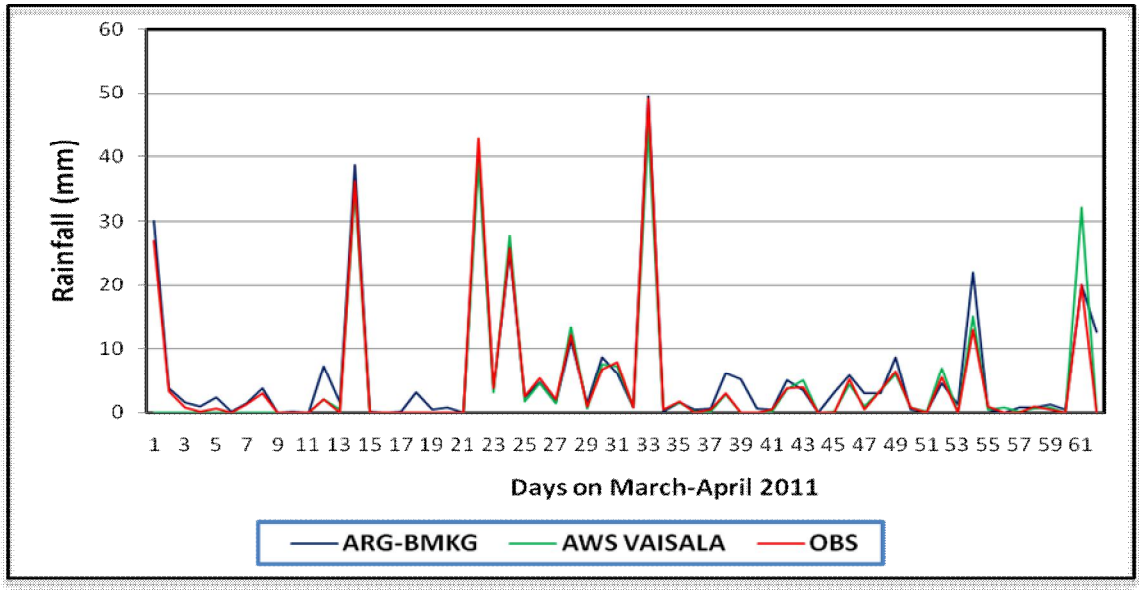


Figure 9. Results of field test at Semarang Climatological Station

Based on the graph in figure 9, it can be seen that the trend of ARG–BMKG's rainfall measurements is quite good compared to rain gauge in AWS-Vaisala and rain gauge by conventional (Observatory Rain Gauge).

V. Conclusions

BMKG's technicians have successful developed an automatic rainfall observation system - based microcontroller ATMega 128, GPRS and web server systems. This instrument is named ARG-BMKG (Automatic Rain Gauge-Meteorogical, Climatological and Geophysical Agency). This instrument have been tested through laboratory tests and field tests with the result was satisfactory. Hopefully, this engineering program can improve knowledge, skill and trouble shooting every BMKG's technician so they can support BMKG's weather instruments maintenance system in Indonesia.

References

[1]*Guide to Meteorological Instruments and Methods of Observation* (WMO-No.8, Seventh edition), WMO, Geneva, 2008.

[2]Guide *to the Global Observing System* (WMO-No.488, Third edition), WMO, Geneva, 2007.

[3]Mark Alberts, *BASCOM-AVR user manual - Version 2.0.7.5 document build 45*, MCS Electronics, German, 2009.

[4]*Introduction to LabVIEW™ Six-Hour Course*, National Instruments Corporation, Texas, 2003.

[5]*Doe Fundamentals Handbook-Electrical Science,* U.S. Department of Energy, Washington, D.C, 1992.

[6]*Fastrack Xtend User Guide-Fastrack Xtend Plug & Play*, Sierra Wireless, Canada, 2009.