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DEVELOPMENT OF SPACE WEATHER MONITORING PLATFORM FOR SPACE AND EARTH'S ELECTROMAGNETISM OBSERVATION

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ABSTRACT

Conditions of space weather are unpredictable. The main reason to monitor the solar activity is to protect the satellites, navigations system and power grid system from breakdown. Development of space weather monitoring platform begin with gathering the several websites into one platform. The space weather parameters are divided into four main areas such as sun, interplanetary space/solar wind, magnetosphere and geomagnetic. Website builder used in this platform is WordPress domain by Universiti Teknologi MARA Shah Alam. Raw data taken was analyse and plotted by using MATLAB R2013a. Space and Earth's Electromagnetism University Teknologi MARA (SEE-UiTM) platform is successfully developed. The platform will display space weather parameters and space weather report in a consecutive day, weeks and month. The platform can be used by students, lecturers and researchers to monitor sunspot activity and geomagnetic event daily, weekly and monthly. It is the first space weather monitoring platform in Malaysia by having database and premium domain. This platform can be more practical, which it can give maximum benefit to the user.

Keywords: space weather website, solar wind, solar flares, coronal mass ejection, geomagnetic storm.

INTRODUCTION

At the surface of the Sun, there is sudden brightening released by magnetic energy stored in corona of the Sun called solar flare. The energy released approximately $6x10^{25}$ J and follows by Coronal Mass Ejection (CME). Through the corona of the Sun, this solar flare ejects cloud of electrons, ions and atoms. Massive solar flare associated with CME may produce geomagnetic storms [2] that can damage electric power [7] for extended period of time. X-rays and UV radiation that is emitted by the solar flare can affect Earth's ionosphere and disrupt long range radio communication. Many countries around the world, including countries in Europe and Asia are focusing on developing digital learning contents and specialist devices and software in order to introduce information and communications technology to education and schools [1]. Since space weather studies are relatively new in Malaysia, this paper will discuss the development of space weather monitoring platform named as Space and Earth's Electromagnetism-Universiti Teknologi MARA (SEE-UiTM). This platform is beneficial and act as a gateway for researcher to monitor space weather events. The assigned members or researchers will prepare daily, weekly or monthly space weather report and get approval from lecturer before it is publicized. The navigation panel is arranged systematically to help new researchers or beginners to understand the space weather monitoring processes. With this platform, the space weather monitoring process will become easier and systematic. Hopefully, this platform can encourage more researchers and students to explore deeply into this area of study.

The created WordPress website named as SEE-UiTM is an abbreviation of "Space and Earth's Electromagnetism- Universiti Teknologi MARA". SEE-UiTM can be considered as a practical compilation of space weather websites. This platform is a cloud-based development that enables user to design and construct the website based on their desire and creativity. This platform are based on PHP server side scripting language designed and MySQL open-source relational database management system. By the present of this platform, students will utilized it for monitoring and observing space weather event as all the information and data needed by the students can be obtained from this website. Thus, it will help students, researchers and workers to observe and monitors space weather event comprehensively. This website consists of nine navigators at the navigation panel; Home, About, Weekly Space Weather Report Form, Sun, Interplanetary Space, Magnetosphere, Geomagnetic, Space Weather Report, MAGDAS Station, Contact Us and Gallery.

METHODOLOGY

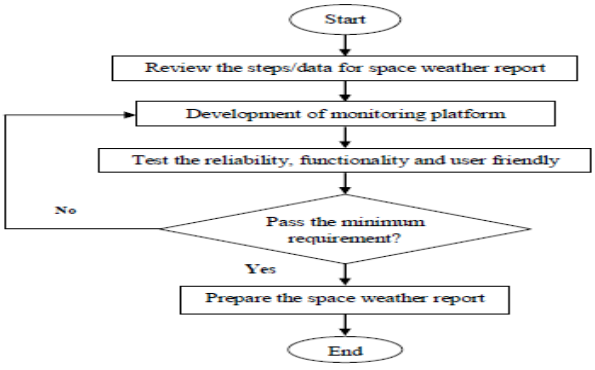

Figure-1. The flowchart development of SEE-UiTM platform.

This part explained briefly all the steps that involved upon completing this project. Figure-1 shows the general flowchart of this project.

Starting

This project started by having a few meetings with the supervisor, Dr Mohamad Huzaimy Bin Jusoh before decided to do the project on developing the space weather platform. This project is chosen due to the current ineffective ways of extracting the data and preparing for the space weather report.

Reviewing the steps/data needed

After the project is decided, the process of researching and reviewing the steps/data needed for the space weather report and the contents for the monitoring platform are gathered. These is to make sure that the goals are achieved and the process of monitoring, preparing for report and as well as the learning process for the new researcher or beginner will run smoothly. the space weather report is all about the daily check on the 4 main areas which are sun, interplanetary space/solar wind, magnetosphere and geomagnetic. There are certain parameters that need to be monitored in every area.

Developing the monitoring platform

The third stage is about the development of monitoring platform. It is when Wordpress is set to be used as the website-builder. SEE-UiTM is a web page that is built from the scratch where it first started with a blank page. The developing process in Wordpress can be done using their drag and drop tools. The contents inside this platform is arranged and well-organized so that the monitoring and learning process can be done comprehensively.

Test performance

The minimum requirements of reliability, functionality and user friendly are analysed during this stage. This is performed by the SEE group members as they are asked to operate this platform without any assistance. If there is no problem with the reliability, functionality and user friendly, they can continue do the preparing for space weather report process. But if there are some troubles in operating SEE-UiTM, the developing process need to be re-do until the minimum requirements are achieved.

To begin the writing report, student must identify data needed for space weather report. The student must browse to the several websites for example, sunspot number (from solar monitor website), solar wind speed, solar wind input energy and solar wind dynamic pressure (from ACE Real Time Solar Wind website), disturbance storm time index (from geomagnetic data service website) and H-direction of geomagnetic field (from INTERMAGNET website). Then, all the websites mentioned will be merge under one platform by using coding [iframesrc="link of website" width="979" height="1500"]. After that, the data taken must be plot using MATLAB software. The graph of solar wind input energy is plotted from Akasofu [4] Equation .(1)

$$\varepsilon = VswB^2F(\theta)(Io^2) \quad (1)$$

where Vsw = solar wind speed, B = solar wind magnetic field magnitude, θ = polar angle of the solar magnetic field vector projected onto the y-z plane, Io: cross sectional area Io = 7Re which Re=6371 km (Earth's radius). While for the solar wind dynamic pressure, it is plotted based on the Equation. (2):

$$Pdyn = 1.6726e^{-6}NVsw^2 \quad (2)$$

where N = proton density and Vsw = solar wind speed. After that, the result must be written in the report. The report must be validated by authorized lecturer before publicized into the website. If the report has been approved, then it can be upload at the website for references. If it is not, the student must check back the data plotted and send back the report.

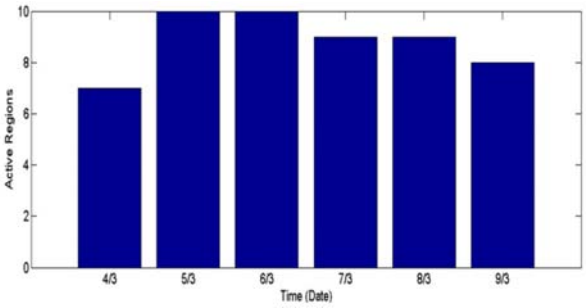

Figure-2. No. of active regions.

RESULTS AND DISCUSSIONS

GOES x-ray satellite is used by National Oceanic and Atmospheric Administration/ United State Air Force (NOAA/USAF) to identify sunspot activity at the Sun. Based on result shows at Figure-2, on 5th and 6th March 2016 the active regions is 10. Active regions are sunspot number appeared at the surface of Sun. It is connected with each other, Active regions is classify prior to its size and complexity with a scale known as a modified Zurich scale [5].Besides, on this week there are C-class of solar flare happened on 4th, 5th, 8th and 9th March 2016. The data can be extracted from the Solar Monitor website which is available under the SEE-UiTM Sun's navigator.

NASA Advanced Composition Explorer (ACE) satellite is orbiting at Sun-Earth Langrange-point 1. At this point, gravity of the Sun and Earth have equal pull thus ACE can measure solar wind and interplanetary magnetic field before it reach magnetosphere. ACE will give 15 min to one hour warning of the arrival of damaging space weather events at Earth [6].

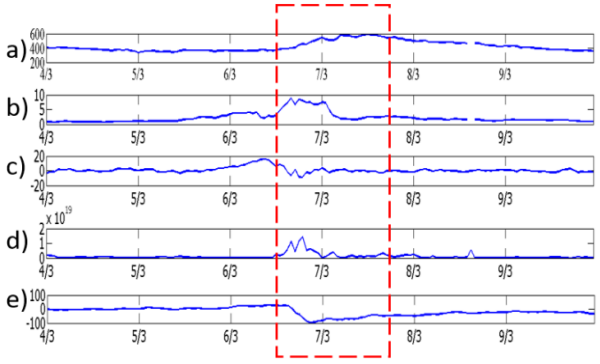

Figure-3. Parameters of space weather.

Figure-3 shows the reading of a) Solar Wind Speed, b) Solar Wind Dynamic Pressure, c) Interplanetary Magnetic Field (Bz), d) Solar Wind Input energy and e) DST index from 4th March 2016 to 9th March 2016. According to Figure-3(a), the highest reading of solar wind speed was on 7th March 2016, it was 631.9km/s. However, the speed is gradually increased starting on 6th March 2016. It is correlated with the number of active regions which is increase from 7 to 10 on 6th March 2016. Figure-3(b) shows graph of solar wind dynamic pressure. The value starts to increase on 6th March 2016 with the highest value 13.27nPa. Based on Figure-3(c), on 6th March 2016, reading of IMF (Bz) declined to -18.4nT. For the Figure-3(d), graph of solar wind input energy fluctuated on 6th March 2016 compared to the stable reading two days before. Last but not least, Figure-3(e) was the reading of DST index [3]. The graph was slowly climb to 24nT on 6th March 2016, then rapidly decreased to -96nT on 7th March 2016.

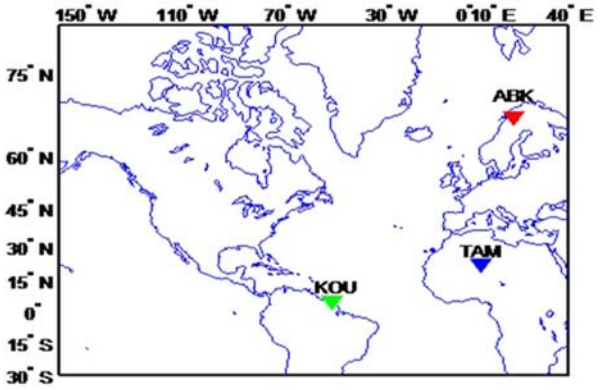

Figure-4(a). Map of high, mid and low station.

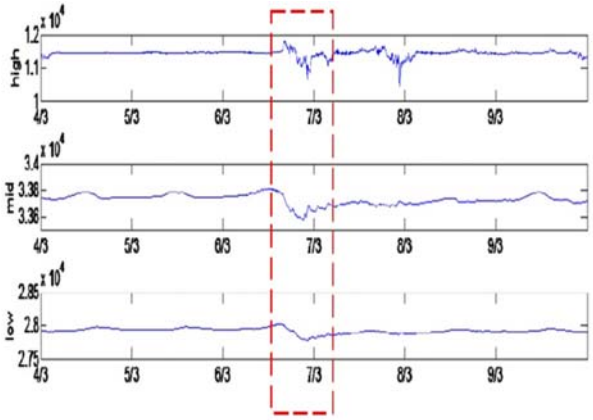

Figure-4(b). Reading of high, mid and low latitude on 4th March until 9th March 2016.

Figure-4(a) shows map of high, mid and low latitude station. While Figure-4(b) shows reading of H-component of geomagnetic field at high latitude (Abisko Station 68.358°/18.823°), mid latitude (Tamanrasset Station 22.79°/5.53°) and low latitude (Korou Station 5.21°/307.27°) from 4th March 2016 to 9th March 2016. The raw data was taken from International Real-Time Magnetic Observatory Network Magnetometer (INTERMAGNET). From the results shows the three stations detects geomagnetic impulse on 6th March 2016.According to the pattern of graph, it is slowly decreased to southward and turn back to normal reading on the next day 7th March 2016.

DISCUSSIONS

The analysis has been made based on the space weather parameters. The maximum solar wind speed reached 631.9 km/s on 7th March 2016. The increasing of solar wind speed was due to the Co-rotating Interacting Region (CIR) where slow plasma compressed by faster plasma behind, creating a region of compression while faster plasma outrunning slower plasma behinds creates an expansion wave or rarefaction region [8]. This phenomenon occurred more often during declining phase of solar activity. Reading of DST index-96nT on 7th March 2016 defined a moderate geomagnetic storm occurred. Due to the increasing reading of solar wind dynamic pressure 13.27nPa on 6th March 2016, the value of H-component magnetic field at high, mid and low latitude also decrease due to Storm Sudden Commencement (SSC) caused by rapid increase of solar wind pressure incident on the Earth's magnetosphere.

CONCLUSIONS

It can be concluded that the monitoring platform has been successfully developed by using WordPress.org. With the existence of SEE-UiTM, the monitoring and preparing report process can be done effectively as it offers a 'one-stop-centre' to extract and observe all the parameters. Aside from that, it provides full disclosure in theoretical and practical to enhance knowledge in space area for learning and applications. SEE-UiTM is a

platform that shares and spreads the knowledge related with space science interactively as it displays the condition of daily solar events to user. Indirectly, it can increase the exposure and awareness to the public and societies about space weather and its impact on human's life, especially in the electrical grid system, radio communication systems, satellites and etc.

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