# EMBEDDED CONTROLLER-BASED ROTATION ANGLE CONTROL OF CIRCULAR RACK AND PINION TELESCOPE DOME AT KOMPLEKS FALAK AL-KHAWARIZMI

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**A report submitted**
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## DECLARATION

I declare that this thesis entitled "EMBEDDED CONTROLLER-BASED ROTATION ANGLE CONTROL OF CIRCULAR RACK AND PINION TELESCOPE DOME AT KOMPLEKS FALAK AL-KHAWARIZMI is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

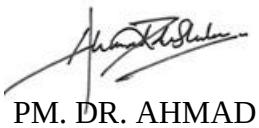
Signature : 

Name : ATIQ FAJAR BIN JAMALI

Date : 5 JULY 2021

**APPROVAL**

I hereby declare that I have checked this report entitled "EMBEDDED CONTROLLER-BASED ROTATION ANGLE CONTROL OF CIRCULAR RACK AND PINION TELESCOPE DOME" and in my opinion, this thesis it complies the partial fulfilment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

Signature : 

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# DEDICATIONS

This study is wholeheartedly dedicated to my beloved parents, who have been the source of inspiration and gave us strength when the thought of giving up arise, who also repeatedly provide moral, spiritual, emotional and financial support.

To my brothers, sisters, relatives' mentor, friends and classmate who shared their kind words of advice and encouragement until the end of this project.

And finally, to dedicate this research project to the almighty Allah, thank you for the guidance, strength, power of mind, protection and skills not to forget for giving a healthy life. All of these, is for you.

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Finally, I would like to express my sincere apology for any mistake or wrong doings in completing this final report. I do hope that this report could benefit others in the future.

## ABSTRACT

The Observatory is a place where the creation and secrets of the universe can be observed and explored. In Islamic society, observatories are among the most important established institutions focused on the growth and advancement of Islamic astronomy or falak. The upcoming *Hari Raya Puasa* for the Muslims in Malaysia is to be on 13 May. This celebration among all Malaysian citizen is extremely awaited. There are about 29 locations for new moon observation in Malaysia. One of them is Kompleks Falak Al-Khawarizmi, Kampung Balik Batu, Tanjung Bidara. The observatory is located in Alor Gajah district and under the supervision of *Jabatan Mufti Negeri Melaka.* Although the telescope system is there, the observatory does not function regularly due to obsolete and errors in the system.

This research will study the previous scholar in order to aid in understanding the development of a dome control system using embedded controller. The development of such system can provide appropriate analysis for research using the telescope. There are three main objectives of this study which is to design a new controller for the dome telescope system, to control the dome using the manual button that was already being used in the current system and to ensure the controller is able to receive command from the user interface software to perform the desired task given. In this project, all of the objectives are successfully achieved and the controller is able to control the dome telescope system. But due to Covid-19 circumstances, the project is performed on prototype dome telescope system. Nevertheless, the function is works and it is able to be controlled to the desired movement.

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## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| Dr. | - | Doctor |
| Prof. | - | Professor |
| Ts. | - | Technologists |
| V | - | Voltage |
| mm | - | Milimeter |
| KM | - | Kilometers |
| C | - | Celcius |
| L.C.D. | - | Liquid Crystal Display |
| L.E.D. | - | Light Emitting Diode |
| I/O | - | Input or Output |
| MOS | - | Metal Oxide Semiconductor |
| MOSFETs | - | Metal-Oxide-Semiconductor Field-Effect Transistor |
| PIC | - | Peripheral Interface Controller |
| MOSTE | - | Ministry of Science, Technology and Environment |
| ANGKASA | - | National Space Agency or ‘Agensi Angkasa Negara’ |
| BAKSA | - | ‘Bahagian Kajian Angkasa’ |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

An Embedded Controller can be viewed as a microcontroller, with I/O and interior highlights focused to suit the regular requirements of a low power platform [1] [2]. The beginning of microcontroller can be followed back to the MOS integrated circuit, which is an incorporated circuit chip manufactured from MOSFETs (metal-oxide-semiconductor field-effect transistors) and was created in the mid-1960s [3] [11]. By 1964, MOS chips had arrived at higher semiconductor thickness and lower fabricating costs than bipolar chips. MOS chips additionally expanded in unpredictability at a rate anticipated by Moore's law, prompting large-scale integration with many semiconductors on a solitary MOS chip by the last part of the 1960s. Implanted regulator are normally found in shopper, mechanical, auto, home apparatuses, clinical, telecom, business, military applications and science. Illustration of science are humanities, archaic exploration, physiology, science, plant science, science, artificial intelligence, topography, geography, arithmetic, medication, physical science and cosmology.



Astronomy is an investigation of all that past earth. This incorporates the investigations of planet, nearby planetary group, stars, cosmic systems, comets, space rocks, nebulae, moons and the universe. Astronomy is a visual-based science [5]. The ability of perception is crucial for comprehension and disclosure. Numerous cosmic abilities were created gone back to 5000 years prior. Before recorded history even started, individuals had seen the interrelationships between the sun, moon and earth. Perceptions brought about comprehension of timing between day, night and month to month examples of twilight shapes and the seasons. Missing were logical purposes behind these occasions. When there were no responses for normal events, spectators inferred that it was brought about by the activity of divine beings. Consequently, the significance of a telescope comes to clarify the characteristic events that turns out to

have the option to foresee the impending occasion, for example, climate, time, shrouds, or occasions.

The primary telescope patent was applied by Hans Lippershey in 1608 which additionally made him credited as the Inventor of telescope. His case to a gadget that could amplify object multiple times which Galileo Galilei alluded as the "Dutch perspective glasses". Anyway in 1609, after Galileo Galilei found out about the "Dutch perspective glasses", he planned one of his own. He has made a few enhancements to the gadget that it could amplify objects multiple times [6]. His improved telescope was utilized to notice and draw out mountains and pits on the moon, just as a strip of diffuse light angling across the sky which is the Milky Way. In current days, for example in Kompleks Falak Al-Khawarizmi, the observatory's telescope is used in deciding the starting of Islamic calendar months, especially the months of Ramadhan, Syawal and Zulhijjah which are related to fasting and celebration of the Muslims in Malaysia. The observatory in Kompleks Falak Al-Khawarizmi is not a classical telescope like used in the early days and now has integrate the function of embedded controller for automation in controlling such as the rotation angle of the circular rack and pinion dome.

## 1.2 Motivation

Astronomy has a great deal of secrets standing by to be addressed. Until this day, there are uncountable measure of revelations identified with the astronomy. The top disclosures are stars circling the Milky Way's dark opening, accelerating universe, Planets found in tenable zone, first picture of a dark opening, planetary beginning, picture of exoplanet, light from gravitational wave direct estimations of the spectra of exoplanets, astronomical temperature and record-breaking planetary framework [5]. These revelations are made with the existance of astronomy field and there is as yet immense measure of opportunities for disclosures of new marvel or actual item in the universe. Moreover, the public interest toward astronomy is gigantic because of the interest of the general public toward the new universe revelations and occasion. One of the gadgets utilized in astronomy to find far off article is the telescope

Telescope is a gadget that has been utilized for most recent couple of a very long time to see through the sky [7]. It has three essential capacity which is light

assembling, settling and amplifying. Light assembling power is a proportion of how much light the target can gather from far off items. The settling power is a proportion of the measure of detail that is conceivable to find in the picture. At long last, the amplification is that the telescope should be made to do to have the option to see anything through it [5]. This telescope innovation rises interest for astronomy advocate. For them, a telescope is an essential requirement in seeing celestial object in the sky. Without it, example of stars in the sky is difficult to be seen utilizing the unaided eye. In current days, a great deal of innovation has progressed into consolidating this fundamental capacity with computer to perform task quicker and can be robotized.

Automation in daily life and activities has been seen to grow exponentially with developing science knowledge. Automation consists in making systematic operations requiring human engagement. It helps in doing simple and repetitive tasks which still require precision. The implementation of automation in telescope is seen able to help in positioning the telescope for the user to specific coordinate. This is due to the highly accurate and precise measurement of distance is required to point the telescope toward the destined object to be observed to ensure the exact location of the object to be observed. This may help in the findings of new physical distant object in the cosmos.



## 1.3 Problem Statement

In Malaysia, there are currently 8 observatories available each for specific type of use. One of the observatories are Kompleks falak Al-Khawarizmi. Kompleks falak Al-Khawarizmi's telescope control station is originally built to solve issue related to Astrofiqh such as the start of Islamic month. But, due to some circumstances, the Kompleks falak Al-Khawarizmi does not function as usual. The current telescope software is not compatible with the telescope making it unable to function. The current dome control system has trouble in opening the upper shutter thus, making autonomous shutter opening impossible. Therefore, this project is to be able to make the system function again with some improvement but limited to the dome's control system.

A telescope lens is highly sensitive to dust particle, rainwater and high temperature [2]. A dust particle in the lens may interrupt with the light received from the observed object making it seems blurry. A water droplet on the lens may mess up the current focus of the length since water has the characteristic to diffract light. Therefore, a dome telescope system is required to prevent the telescope from operating in unsuitable weather condition and prevent unwanted error or hardware malfunction.

From the stated problem above, a faster and more robust controller is required to improve the current PIC control system. In addition, the current controller has trouble in receiving with user computer and its automation. Thus, it is required to find a more suitable microcontroller to replace the current PIC control system.

## 1.4 Objectives

1. To design a new controller for the dome telescope that is able to perform basic task of dome telescope with the automation using the sensor provided.
2. To control the dome using the manual button that was already used in the current system.
3. To ensure the dome telescope system is able to receive command from user interface software and perform the desired task.



## 1.5 Scope

1. Focus on developing the control system for the dome telescope using Arduino microcontroller.
2. Focus on the display and button provided to be used with the new microcontroller.
3. Able to have the microcontroller to communicate with user interface in computer.

4. Using Arduino Nano as microcontroller.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

For this chapter, literature reviews are carried out by studying from validated resources such as articles, newspapers, and conferences, before to relativity with this project. Reviews on related research regarding on the embedded controller-based rotation angle control for dome telescope. The evaluation of each component, method and technique of comparison is listed in this chapter. This section reviews some research or project that has some resemblance that other researchers have conducted. This project is about the development an embedded controller-based rotation angle control of circular rack and pinion telescope dome at Al Khawarizmi Observatory.

## 2.2 Overview of Astrofiqh

The topic of Fiqh is the depiction of various types of love and exchanges and their Islamic decisions. These apply to all that an individual does including petition, fasting, zakat and business exchanges. In astrofiqh, it alludes to sciences which completes exercises of instructive, exploration and the travel industry nature identified with the study of Islamic astronomy (falak), especially in issues relating to Muslim love ceremonies, for example, the assurance of qiblah bearing and estimation of supplication times.[14][15]

Daily prayers have been oriented with the orientation of the sun in the sky. Finding the position of Mecca has required many believers to look at the stars or, currently, connect to a satellite. The starting day of the months, including Ramadan, have based on the visibility of the moon. Astronomy has thus had a central place in Islamic tradition. In addition, they have also bestowed to global science through planetary models and calculation. They also present as a bridge between the geocentric model of Ptolemy and the heliocentrism of Nicolaus Copernicus in Europe [15]. The study of present astroculture, including science fiction, also requires methods of analysis from outside of the history of mathematical astronomy, such as art and literary criticism.

The present study in astrofiqh has improved the accuracy regarding prayer timing. It is principal though Islam gives some relaxation of about +5 or -5 minutes in actual timing without any issue. The table results below is the new tweak formula shows that almost all timing of selected countries falls within the time interval of -5 to +5, whereas the result with old formula do not lie in this timeframe [15]. Therefore, it is proven that present study in astrofiqh has benefits muslims all around the globe. Furthermore, with the study in other parameters like altitude of some place can also be included in the improved modelling. The following Table 1 is the result taken from Alam [15] which shows the comparison between old formulas with the new improved formula.

**Table 1 : Result of astrofiqh adaptation in prayer time**

| Prayer Name | Actual Time* | Result with Old Formula | Result with New Improved Formula | Time Difference (OLD) | Time Difference (NEW) | Error (OLD)% | Error (NEW) % |
|---|---|---|---|---|---|---|---|
| **Greenland (Nuuk, Sermersooq)** | | | | | | | |
| **Fajr** | 5:05 AM | 5:27 AM | 5:09 AM | +22 min | +4 min | 6.35 | 1.15 |
| **Zuhar** | 12:39 PM | 12:53 PM | 12:42 PM | +14 min | +3 min | 4.04 | 0.87 |
| **Asr** | 2:48 PM | 3:09 PM | 2:54 PM | +15 min | +6 min | 4.33 | 1.73 |
| **Maghrib** | 5:35 PM | 5:28 PM | 5:34 PM | -7 min | +1 min | 2.02 | 0.29 |
| **Isha** | 8:06 PM | 8:09 PM | 8:03 PM | +6 min | -3 min | 1.73 | 0.87 |
| **Pakistan (Quetta, Balochistan)** | | | | | | | |
| **Fajr** | 5:41 AM | 5:57 AM | 5:40 AM | +16 min | -1 min | 4.61 | 0.29 |
| **Zuhar** | 12:44 PM | 12:49 PM | 12:44 PM | +5 min | 0 min | 1.44 | 0.00 |
| **Asr** | 4:00 PM | 4:21 PM | 4:02 PM | +21 min | +2 min | 6.06 | 0.58 |
| **Maghrib** | 6:28 PM | 6:35 PM | 6:29 PM | +3 min | +1 min | 0.87 | 0.29 |
| **Isha** | 7:48 PM | 8:02 PM | 7:50 PM | +14 min | +2 min | 4.04 | 0.58 |
| **Brazil ( Gaspar, Santa Catarina)** | | | | | | | |
| **Fajr** | 4:47 AM | 5:01 AM | 4:54 AM | +14 min | +7 min | 4.04 | 2.02 |
| **Zuhar** | 12:28 PM | 12:16 PM | 12:27 PM | +12 min | -1 min | 3.46 | 0.29 |
| **Asr** | 3:59 PM | 4:08 PM | 4:02 PM | +9 min | +3 min | 2.60 | 0.87 |
| **Maghrib** | 6:49 PM | 6:54 PM | 6:50 PM | +5 min | +1 min | 1.44 | 0.29 |
| **Isha** | 8:04 PM | 8:00 PM | 8:04 PM | -4 min | 0 min | 1.15 | 0.00 |
| **Australia (New Castle , New South Wales)** | | | | | | | |
| **Fajr** | 5:12 AM | 5:23 AM | 5:13 AM | -11 min | +1 min | 3.17 | 0.29 |
| **Zuhar** | 1:05 PM | 1:19 PM | 1:10 PM | +14 min | +5 min | 4.04 | 1.44 |
| **Asr** | 4:42 PM | 4:31 PM | 4:40 PM | -11 min | -2 min | 3.17 | 0.58 |
| **Maghrib** | 7:32 PM | 7:25 PM | 7:28 PM | +7 min | +4 min | 2.02 | 1.15 |
| **Isha** | 8:53 PM | 8:52 PM | 8:50 PM | -1 min | -3 min | 0.29 | 0.87 |
| **Kuwait ( Salwa)** | | | | | | | |
| **Fajr** | 4:55 AM | 5:09 AM | 4:55 AM | +14 min | +0 min | 4.04 | 0.00 |
| **Zuhar** | 12:00 PM | 12:07 PM | 12:01 PM | +7 min | +1 min | 2.02 | 0.29 |
| **Asr** | 3:17 PM | 3:20 PM | 3:18 PM | +3 min | +1 min | 0.87 | 0.29 |
| **Maghrib** | 5:44 PM | 5:41 PM | 5:42 PM | -2 min | -2 min | 0.58 | 0.58 |
| **Isha** | 7:14 PM | 7:15 PM | 7:13 PM | +1 min | -1 min | 0.29 | 0.29 |

## 2.3 Overview of Observatories in Malaysia

Observatory is nearly linked with observation studies and theories on celestial objects, the space between them and the universe on the whole. Observed objects consist of the sun, moon, planets and stars. The technology of observatory construction occurred since the 8th century and it was considered as one of the important Islamic institutions alongside schools and mosques. The Islamic civilization era was the birth era of observatory constructions and since then an evolution occurs from time to time to the rest of the world.

The term ‘observatory’ in Malay is ‘balai cerap’. As stated by Kamus Dewan [21], the word ‘balai’ means a hall, house (for public) or building specially built for a certain purpose while ‘cerap’ means to observe, to view, an action or a process of observing certain phenomena and to accept a certain thing in the heart using senses such as sight or hearing. At the present, ‘balai cerap’ is interpreted by Kamus Dewan [21] as a building which is equipped with certain equipment to enable scientists and others to make observation and prediction on weather phenomena, position and movement of celestial objects.

According to Othman [22], observatory is an institution for astronomy experts to study
The universe. They examine emissions or images from celestial bodies to form theories in the universe. Therefore, observatory has been a basic amenity without which the advancement of astronomy science seen today would have not been able to achieve. Meanwhile Aziz [23] defines observatory as a place used for observing phenomena of the universe, either directly using human senses or with the help of instruments. The existence of observatory greatly contributes in the field of astronomy and at the same time defines the level of excellence of a civilization.



### 2.3.1 Sheikh Tahir Falak Centre

The story of astrofiqh observatory construction in Malaysia commenced in the late 1980’s with the building of the Sheikh Tahir Falak Centre in Penang. This center was first construct in 1988 and later officially opened on the 9th of October 1991. Its construction marked the beginning of the elevation of falak in Malaysia at that time. The center also act as an astronomy and atmospheric science research station for the

Penang State Mufti Department and the Falak and Atmospheric Sciences Research Unit, Universiti Sains Malaysia. Sheikh Tahir Falak Centre is placed in Pantai Acheh, which is in the westernmost part of Penang. It was construct on a hill at a height of 40m from sea level. Its place which is far from the hustle and bustle of the city renders the observatory a suitable place to carry out observation activities.

The 123th Conference of Malay Rulers on the 18th of February 1982 allow the observatory site being made an official site for hilal sighting for Ramadhan, Shawwal and Zulhijjah [13]. The Sheikh Tahir Falak Centre was named after a specialist in the field of falak shar'ie in the Malay realm, Sheikh Tahir Jalaluddin. He was an Islamic scholar who obtained his high education in the Middle East and was well-renowned in the Malay Archipelago for his mastery in two disciplines of knowledge, namely fiqh and *falak.*

### 2.3.2 The National Planetarium Observatory

The history of the National Planetarium Observatory started with the setting up of Planetarium Division in the Prime Minister's Department in the year 1989. The building of the observatory was listed in the construction project of the National Planetarium Complex which began in 1990 and was fully completed in 1993. Bahagian Kajian Angkasa (BAKSA) or the Space Studies Division was recognized with its responsibility broadened to include sciences and outer space. Its uncertified launching was in May 1993 and the complex was officially opened by the fourth Prime Minister of Malaysia, Tun Dr. Mahathir Mohamad on the 7th of February 1994. After functioning for one and a half year, the division was moved to the Ministry of Science, Technology and Environment (MOSTE) in July 1995. In 2002, the National Space Agency or Agensi Angkasa Negara (ANGKASA) was acknowledged and mandated with the power to set policies and regulate, coordinate, implement and monitor space activities.

Later on, BAKSA and ANGKASA were combined in 2004 and become National Planetarium Observatory. The National Planetarium Observatory began functioning in 1993 and all systems were handled manually. Observation dome and the telescope system were controlled by staff designated with the duty of operating them. Operation of the telescope at that time was manually done due to the telescope

mounting which was Takahashi NJP Mounting was not automated. Due to problems faced in controlling the observatory dome and the telescope at that time, the whole operation system at the observatory was replaced by a fully robotic system in 1999. Afterward, the operation system of the dome and the telescope was fully controlled robotically by computers until now.

The National Planetarium Observatory is placed at Lake Garden, Kuala Lumpur near the National Museum, Tun Abdul Razak Memorial and the Museum of Islamic Arts. It was constructed on a tower at a height of 112m above sea level. The National Planetarium Observatory is suited with state-of-the-art equipment befitting the objective of its establishment as a center of space science studies in Malaysia. This observation tower uses a semispherical dome with a diameter of 5m and automatic controls [13]. The dome was constructed in two layers, an inner layer made from fiber glass and an outer layer made from rust-resistant alloy. The motive of building the planetarium observatory is for public education. It has the objective of showing the public to outer space through a combination of space science knowledge, cultures and religion.

### 2.3.3 The KUSZA Observatory

In line with the growth in the field of astronomy in the 1990's, construction of an observatory in Bukit Merang, Setiu was proposed with the intention to enhance the advancement of astronomy in the State of Terengganu specifically and Malaysia generally. This observatory began to be constructed in 1992 and was fully completed in 1995 The observatory is managed by Universiti Sultan Zainal Abidin (UniSZA) formerly known as Kolej Ugama Sultan Zainal Abidin (KUSZA) under the supervision of Falak Unit, Faculty of Islamic Contemporary Studies (FPKI). The observation tower is one of the official hilal sighting locations in Malaysia. In the beginning, the observation tower used the name 'Bukit Merang Observatory', but that was later renamed to 'KUSZA Observatory' which is still used until today [13].

The KUSZA Observatory is placed in Bukit Merang, Setiu, Terengganu about 26km away from the main campus of UniSZA. It was built on a hill at a height of 112m over sea level. In the 160th Conference of the Malay Rulers held on the 11th of

February 1993, the site of the observatory was specified the royal assent by the Council of Malay Rulers to become one of the official hilal sighting place for Ramadhan, Shawwal and Zulhijjah. The KUSZA Observatory is suited with an aluminum dome of diameter 5m with wooden inner layer. The hemispherical dome is manually controlled and the observatory is also suited with other facilities such as a mini-planetarium, exhibition gallery, lecture rooms, observation field and prayer rooms. As an observatory handled by a local university, the setting up of the KUSZA

Observatory is more focused towards the aspect of education. Numerous activities related to astronomy education are organized at the observatory, among which are hilal observation every Hijri month, night sky object surveillance, periodic courses, demonstration of telescope operation and open-day programs. Besides, the observatory also aids as a practical training place for astronomy students of UniSZA who take the co-curriculum subject or elective course of falak shar'ie. Not restricted to an education institution, the KUSZA Observatory is also open for those who are intrigued in carrying out research activities related to astronomy

### 2.3.4 Al-Khawarizmi Falak Complex

The Al-Khawarizmi Falak Complex, Malacca was constructed in 2002 and was later officially opened on the 1st of December 2007. Proposal for the establishment of the observatory was mooted to expand and enable efforts of managing worship affairs of the Muslims involving falak such as determining the starting date of the Hijri months and calculating prayer time. The Al-Khawarizmi Falak Complex is placed in Kampung Balik Batu, Tanjung Bidara in the District of Alor Gajah and is about 25km from the city center of the Historical City of Malacca [13]. Originally, this observatory was a normal observation site which was owned by a local resident by the name of Mr. Abdul Karim bin Mohd Amin. Later on, the land was bestowed or made a waqaf land to the State of Malacca Mufti Department to be gazetted as an official hilal sighting site. Its position is on the shore facing the Straits of Malacca. It was also constructed to face the qiblah.

The position of the observatory at an altitude of 44m over sea level prevents it from any obstruction such as tall buildings and trees. In addition, it has a broad angle of west horizon view of 240º- 295º. In the 185th Conference of Malay Rulers on the

23rd of March 2000, the observatory got the royal approval from the Council of Malay Rulers to become one of the official hilal observation sites for determining Ramadhan, Shawwal and Zulhijjah. The Al-Khawarizmi Falak Complex was called after a highly knowledgeable Islamic figure for his knowledge in the fields of philosophy, mathematics, astronomy and history, namely Al-Khawarizmi. He was the most well-known mathematician who pioneered several important branches and fundamental concepts of mathematics. The term 'algebra' today is evidence of his great contribution in the field of mathematics to the whole world.

### 2.3.5 The Al-Biruni Observatory

In the year of 2004, the Al-Biruni Observatory in the State of Sabah started to be built. Establishment of the observatory was not only for the purpose of hilal sighting but it also is to function as a motivation for education, research and the tourism sector. In addition to that, this observatory plays the part of generating growth in the field of falak in Malaysia particularly in the state of Sabah. It was formally opened on the 29th of October 2007. The observatory is in Tanjung Dumpil, Putatan approximately 15km from Kota Kinabalu and 1km from Putatan within the vicinity of Kg. Contoh, Petagas, Kg. Sri Pandan and Taman Pasir Putih Putatan. The structure which is at 1.7m above sea level is oriented to face the South China Sea facing the Ka'bah. Apart from that, it has a broad angle of the west horizon view, at azimuth 230º-310º.



Gazettement of the observatory site as a validated hilal sighting site for the state of Sabah was made on the 19th of October 2006/26 Ramadhan 1427H for the area of 7.760 hectares or 19.17 acres [13]. The Al-Biruni Observatory was labelled to commemorate an important figure in the fields of mathematics, geography, physics and astronomy. The influencer of al-Biruni in various disciplines of knowledge made him a scholar highly respected by leaders of the Islamic world then and he received special treatment and high position from them. He was once a consultant to the ruler of Khawarizm, Abu al-'Abbas al-Ma'mun.

### 2.3.6 Langkawi National Observatory

Through the institution of the National Planetarium, Kuala Lumpur in 1994, the importance of space science has since grown. In line with the setting up of