RESEARCH ARTICLE   OPEN ACCESS

Auto Adjusting Astronomical Telescope

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ABSTRACT

 Astronomical telescope is powerful and basic tool for star or celestial observation. Here we proposed integrated system using Raspberry Pi for auto adjusting astronomical telescope. This integrated circuit helps to control stellar monitoring, stellar targeting, and tracking functions of telescope. Astro compass gives the direction of the celestial objects.

Keywords – Astro Compass, Online stellar Database, Python Language, Raspberry Pi.

I. INTRODUCTION

Astronomy is natural science that is study of celestial objects. A lot of people are interested in astronomical objects. Astronomy is one of the most difficult subjects in science education, because it requires special astronomical telescope to observe the celestial objects and it appears at nighttime only. [1] And the adjusting the telescope is a time consuming these are drawbacks for astronomers.

In a compass is a navigational instrument that shows directions in a frame of reference that is stationary relative to the surface of the earth. The frame of reference defines the four (i.e. East - West, North – South directions). Stellar or celestial denotes the stars or planets which are in the universe. Astro compass gives the direction of the stellar objects.

In the designing of an astro compass requires the several equations derived from the systems of coordinates defining a body in space relative to one's position on earth at any moment of time.[2]. To derive these equations, a brief description of celestial navigation is required. Celestial navigation is the determination of position and heading by the aid of celestial bodies, i.e., the sun, planets, moon and stars. [2]

Generally to locating celestial bodies there are two systems of coordinates are used. [2] One is the equinoctial or celestial system which designates the position of the celestial body without respect to any point in the earth. [2] The other is the horizon system which locates a body on the celestial sphere in relation to the horizon of the observer.[2]

The earth's coordinate system and that of the celestial sphere are having direct relationship. In the celestial system of coordinates the axis of the earth extended cuts the celestial sphere in two points called the celestial poles.[2] These poles are north and south correspond to the North and South poles of the earth. The plane of the equator of the earth extended cuts the celestial sphere in a great circle which is called the equinoctial or celestial equator.

II. PROPOSED SYSTEM DESIGN

The Proposed integrated system should be connected to the internet for collecting the coordinates from various sites; after collecting the coordinates, motor can rotates to focus on star within time. It can also helpful for star observing and tracking.

As shown in below figure, steps are as follows.
1. Initially Telescope will set at zero[th] position (North Direction) through motor.
2. Then give input to the Raspberry Pi controller through keyboard.
3. Then controller will send query to SIMBAD (online) database.
4. From online database will take response. Database contains coordinates.
5. After getting coordinates to controller, controller will synthesize data.
6. By taking synthesized data, motor will rotate & telescope will move in that direction.
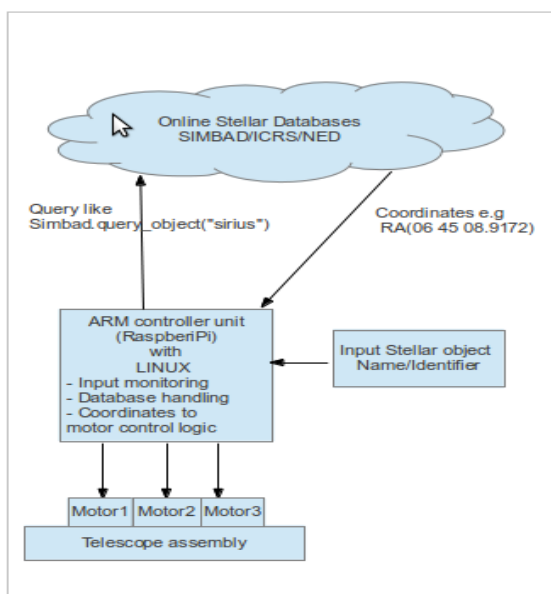
Figure1. Block Diagram of the system

2.1. RASPBERRY PI

The Raspberry Pi is a small single-board computer developed by the Raspberry Pi Foundation. It features a Broadcom System on Chip (SoC) with a 700MHz, ARM1176JZF-S processor, ARMv6 instruction set, and 512MB of RAM. It also includes Video Core IV GPU. For booting & storing data SD card is used, no hard disk or solid state drive is provided. On the board there are many interfaces, for example USB, Ethernet, video and audio and 26 (GPIO) General Purpose Input Output pins [7]. Some of the GPIO pins are for power and some have special functions, such as UART Universal Asynchronous Receiver/Transmitter, SPI Serial Peripheral Interface Bus and I2C Inter-Integrated Circuit [8]. Python is main programming language for Raspberry Pi.

The Raspberry Pi primarily uses Linux kernel based operating systems.

The GPU hardware is accessed via a firmware image which is loaded into the GPU at boot time from the SD card. The firmware image is known as the binary blob, while the associated ARM coded Linux drivers were initially closed source. Application software uses calls to closed source run-time libraries which in turn calls an open source driver inside the Linux kernel.

Figure2. Diagram of the Raspberry Pi

Figure 2 describes the Raspberry pi board. It contains SD memory card slot, USB slot, RJ 45 slot, Micro-USB slot for power supply, General purpose pins, HDMI slot, Audio out slot.

2.1.1. Features of Raspberry Pi
1. The Raspberry Pi is a small device. The size is 85.60mm X 53.98mm X 17mm and weight is 45g.
2. The 3.5mm analog audio jack is provided to connect headphones & speakers to Raspberry Pi.
3. Micro USB is used for power supply. And USB 2.0 is used for keyboard and mouse.
4. The high definition Multimedia Interface (HDMI) port can be used for high definition television and monitors.
5. The Ethernet port is main gateway of Raspberry Pi to communicate with other device & internet.

2.1.2. Connections of Raspberry Pi board [6]:-
1. Plug the preloaded SD Card into the Pi.
2. Plug the USB keyboard and mouse into the Pi.
3. Plug the video cable into the screen (TV) and into the Pi.
4. Plug your extras into the Pi (USB Wi-Fi, Ethernet cable, hard drive etc.). This is where you may really need a USB Hub.
5. Ensure that your USB Hub and screen are working.
6. Plug the power source into the main socket.
7. With your screen on, plug the other end of the power source into the Pi.
8. The Pi should boot up and display messages on the screen.

It is always recommended to connect the Micro-USB Power to the unit last (while most connections can be made live, it is best practice to connect items such as displays/h/w pin connections with the power turned off).

2.2. PYTHON LANGUAGE

Python language is general purpose, high level programming language. Its design philosophy emphasizes code readability, and its syntax allows

programmers to express concepts in fewer lines of code than would be possible in languages such as C.

Python language supports multiple programming paradigms, including object-oriented, functional programming and structured programming. Python is dynamic type system and automatic memory management. It has a large comprehensive standard library. Python is often used as scripting language & non scripting contexts. Python code can be packed into standalone executable programs. Python interpreters are available for many operating systems.

2.3. TELESCOPE

Telescope is an instrument which used to observing remote objects by collecting the electromagnetic waves. Telescope covers a wide range of instruments. Mostly detect electromagnetic waves or radiations, but there is major difference in how astronomers must go about collecting light in different frequency bands.

Telescopes classified by wavelengths of light
1. X-ray telescope.
2. Ultraviolet telescope.
3. Optical telescope.
4. Infrared telescope.
5. Sub millimeter telescope.

Telescopes also classified by locations.
1. Space telescope or flying telescope.
2. Ground telescope.

2.4. ONLINE DATABASE (SIMBAD)

SIMBAD (the set of identifications, Measurements, & Bibliography for Astronomical Data) is an astronomical database. In this database consist of objects beyond the solar system. It is maintained by Centre de données astronomiques de Strasbourg (CDS), France.

SIMBAD offers following functionalities: [9]
1. Query by identifiers and around identifiers.
2. Query by coordinates, specifying the radius and equinox.
3. Query by bibcode and partial bibcode.
4. Sampling with asset of physical criteria.
5. Query by lists of objects, coordinates or bibcodes.
6. Display charts for list of objects resulting from coordinates query.

III. IMPLEMENTATION AND METHODOLOGY

A Firstly give power to the microcontroller Raspberry pi & motor. In our case north position is zero[th] position. The motor will rotate in such way that

telescope will point to North direction. After that give input to the Raspberry Pi. Then the controller will send a query to the online database. The online database (in our case SIMBAD) will give a response which will contain the coordinates of the stellar object name that was queried. After receiving data, data will be synthesised for rotation of motor. Here, three stepper motor are used for three directions viz. X, Y, Z directions. After that hardware alignment will be changed according to position of star or any celestial body.
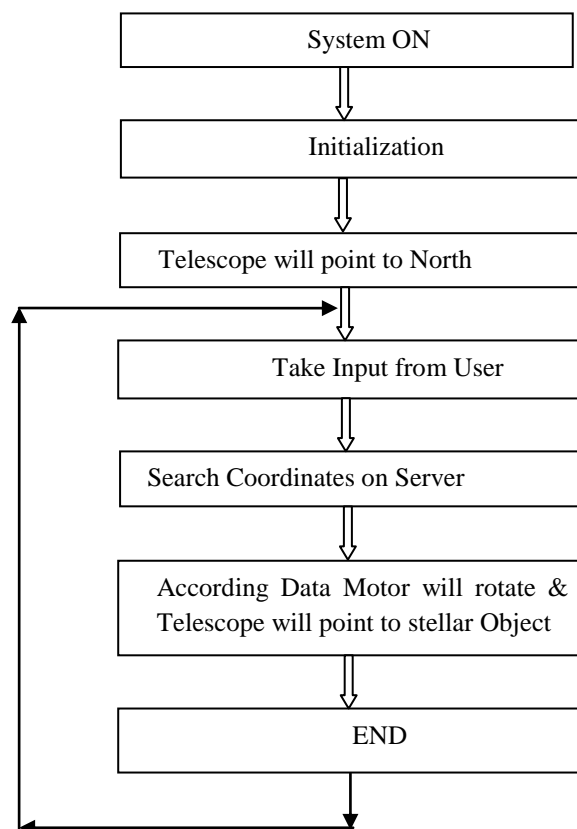

Figure3 Flowchart of the system

In above figure describes flowchart of the system. Initially when system gets ON, it initializes all hardware. Then motor will rotate such that telescope will point to North direction. Then enter the stellar object name, on screen it will display. When we enter name of stellar object, it will search coordinates on server Like SIMBAD. After that this coordinates are synthesized to drive motor. And telescope will moved on required stellar object direction.

IV. CONCLUSION

Raspberry Pi controller is most reliable controller in ARM 11 series. Board size is also small for practical purpose. Using python variety of scripting language can be used. Through Ethernet,

internet can be used for accessing online database such as SIMBAD. And keyboard is used for entering the required stellar objects.

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