CHAPTER FOUR

SIMULATION AND RESULTS

4.1 Chapter Overview:

This chapter covers the system components, android application evaluation system simulation and system implementation.

4.2 System Components:

System components are selected according to the functionality of the automatic satellite dish positioning system; ARDUINO UNO is required to control the movement of stepper motors according to a certain values received from an android device by using Bluetooth. ARDUINO UNO can support Bluetooth easily by connecting a Bluetooth module to the ARDUINO UNO. ARDUINO UNO has low output current that can't drive a stepper motor so a reserved L293D motor driver is used to support each motor with a sufficient current for proper operation. Stepper motors operate at D.C voltage levels proportional to the maximum torque that each motor can handle with during the motor rotation, to minimize the operation cost, A.C to D.C conversion is required to convert 220 v (A.C voltage) to 12 v (D.C voltage) that can be used for the operation of the stepper motors in the system. Figure (4.1) illustrate the block diagram of the system components.

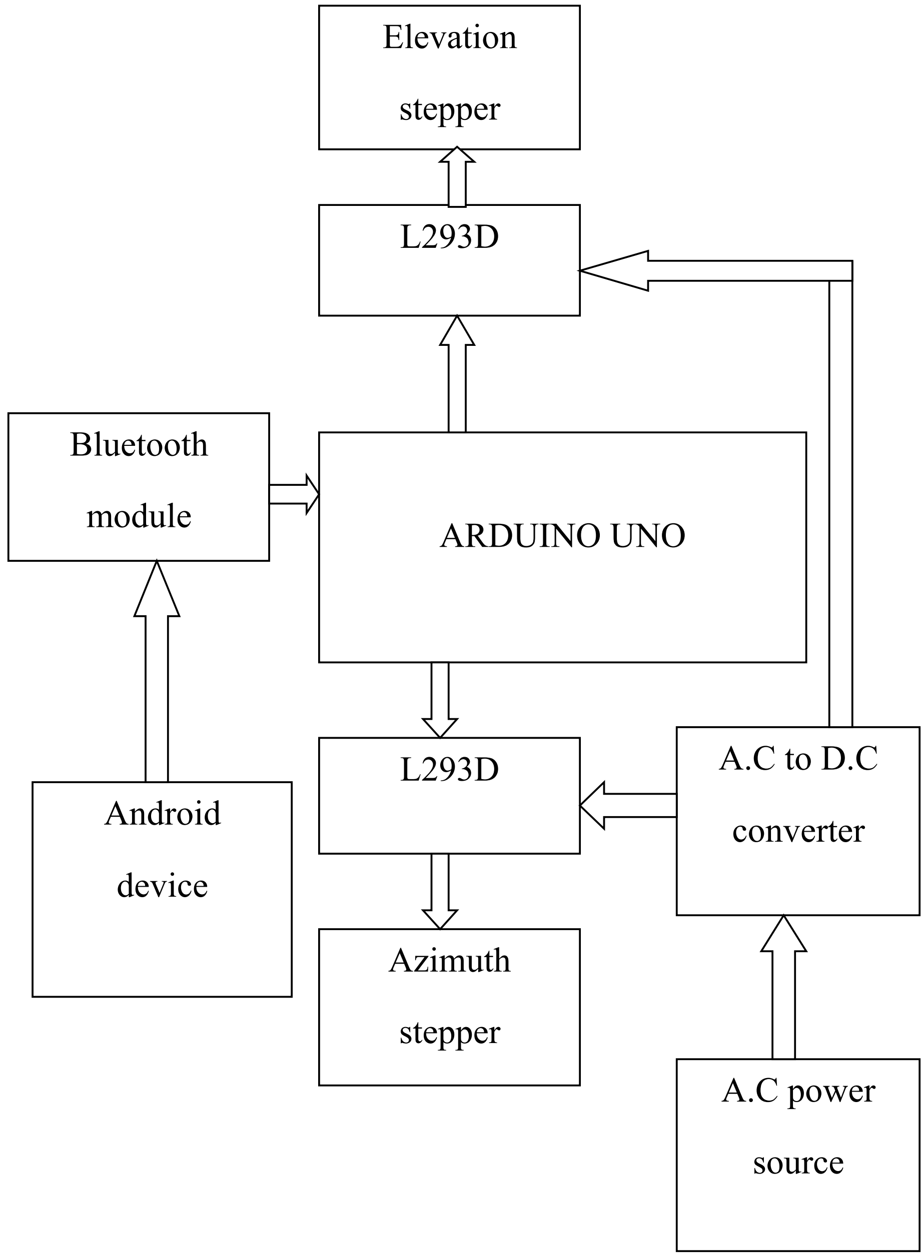

Figure (4.1): Block diagram of the system components.

4.2.1 Android Device:

Android device running an application that calculate the look angles for both of the current and desired satellites and compute the number of steps that each motor has to take for perfectly positioning the dish to the satellite. ANDROID code was included in APPENDEX A.

4.2.2 Bluetooth Module:

Provide interfacing between the ARDUINO UNO and the android device. android device sends a string containing the direction of rotation and the number of steps that each motor has to take to adjust the corresponding angle. The Bluetooth module pass the string to the ARDUINO UNO. Figure (4.2) illustrate the Bluetooth module.

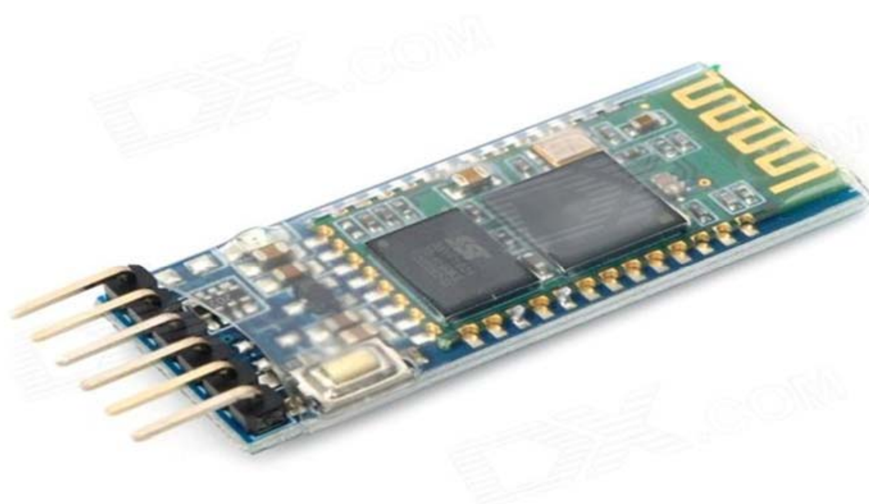

Figure (4.2): The Bluetooth module.

4.2.3 ARDUINO UNO:

The ARDUINO UNO microcontroller as shown in Figure (4.3) features low price, wide range of application, high output signal quality and easy for interfacing with android devices. ARDUINO UNO is an attractive choice in applications that require interfacing with an android device. The selection of ARDUINO UNO has been done due to their inexpensive price, powerful instructions specially for communication with android devices, wide range of interfacing and built in oscillator with selectable speed.

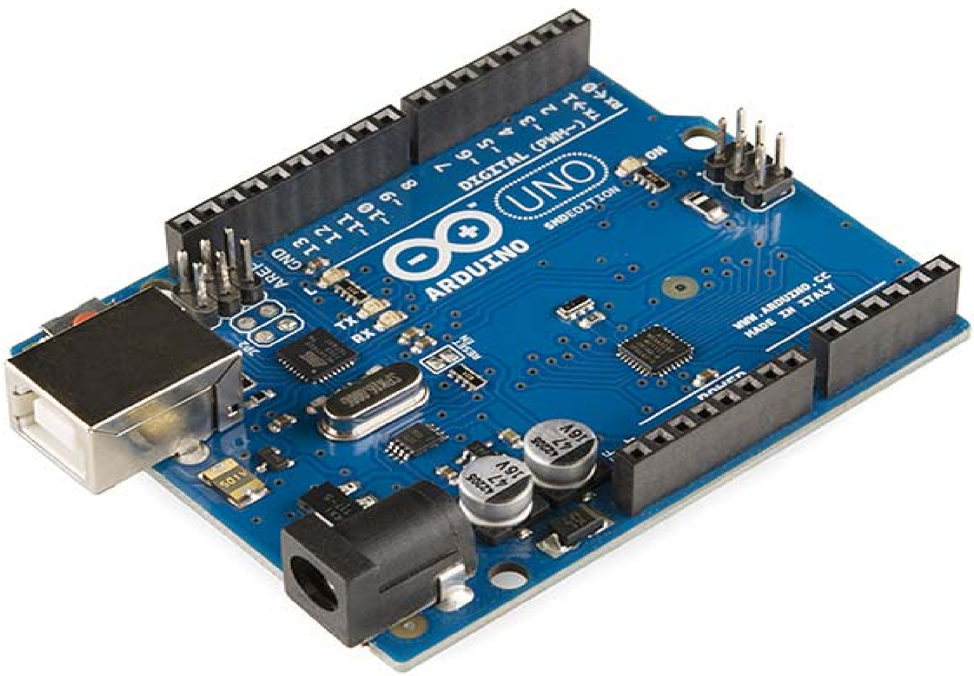

Figure (4.3): ARDUINO UNO

ARDUINO UNO receives string from a Bluetooth module (will be connected to ports 1,2) and extracts it into four parts as follows elevation direction, elevation steps, azimuth direction and azimuth steps. The first two parts for elevation angle aligning (motor will be connected to ports 4,5,6,7) and the remaining parts for azimuth angle aligning (motor will be connected to ports 8,9,10,11). ARDUINO UNO express the values as a number of pulses and each pulse result in one step movement. ARDUINO code was included in APPENDEX B.

4.2.4 L293D:

The output current of ARDUINO UNO is small and insufficient for stepper motor operation. L293D allow operation of the stepper motor at high current level compared to that achieved by ARDUINO UNO. High current level enable proper operation of stepper motor. Figure (4.4) illustrate L293D .

Figure (4.4): L293D Chip.

4.2.5 Stepper Motors:

Stepper motor provide precise positioning. At each pulse the motor move one step. For the system two stepper motors have been selected. Each motor has step angle equal to 0.35 which is less than HPBW.

Figure (4.5) illustrate a stepper motor.

Figure (4.5): a stepper motor.

4.3 Android Application Evaluation Using Serial Monitor:

Android application lies at the heart of the system. It performs the look angles calculations by locating the user using GPS and enabling the user to select both of the current satellite and the desired satellite. Then it calculates the relative elevation and azimuth and uses these values to compute the required steps for each motor. Figure (4.6) show a screenshot of the Main Activity of the Android Application.

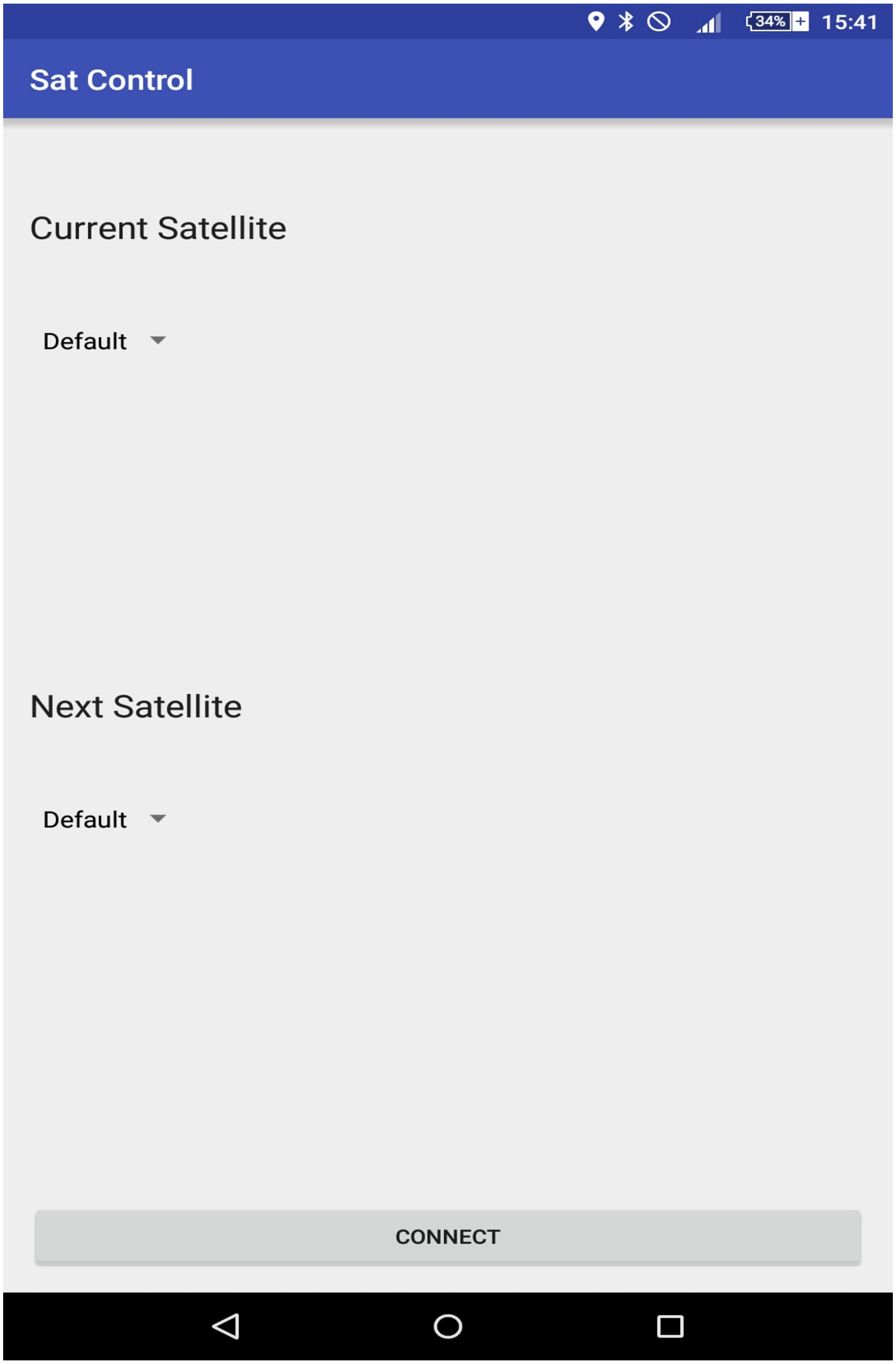

Figure (4.6): Screenshot of the Main Activity of the Android Application.

To evaluate the operation of the application, the resulted angles must be within the HPBW. For capital Khartoum, the following table manifest a list of satellite with their corresponding azimuth and elevation angles.

Table (4.1): List of satellites and their corresponding azimuth and elevation angles for capital Khartoum.

Satellite	Azimuth	Elevation
NILESAT	252.1^0	41.5^0
ARABSAT	203.06^0	70.2^0
DEFAULT	Truly south	0^0

4.3.1 Android Application Result for Moving a Dish from DEFAULT position to NILESAT:

Serial Monitor gives attractive choice to evaluate the performance of the android application. Moving from DEFAULT to NILESAT indicates that the relative elevation angle must be 41.5^0 and the relative azimuth angle must be 72.1^0. Figure (4.7) Show a Serial Monitor captured image of the obtained elevation and azimuth angles for moving from DEFAULT to NILESAT that are computed and wirelessly transmitted by the Android Application. Since the obtained angles are near to the manually computed, the user will receive a strong signal.

```
number of steps for Elevation adjustment
119
number of steps for Azimuth adjustment
206
Relative Elevation Angle
41.65
Relative Azimuth Angle
72.10
```

Figure (4.7): Android Application Result for moving a Dish from DEFAULT position to NILESAT.

4.3.2 Android Application Result for moving a Dish from DEFAULT position to ARABSAT:

Moving from DEFAULT to ARABSAT indicates that the relative elevation angle must be 70.2^0 and the relative azimuth angle must be 23.06^0. Figure (4.8) Show a Serial Monitor captured image of the obtained elevation and azimuth angles for moving from DEFAULT to ARABSAT that are computed and wirelessly transmitted by the Android Application. Since the obtained angles are strongly near to the manually computed values, the user will receive a strong signal.

```
number of steps for Elevation adjustment
201
number of steps for Azimuth adjustment
66
Relative Elevation Angle
70.35
Relative Azimuth Angle
23.10
```

Figure (4.8): Android Application Result for moving a Dish from DEFAULT position to ARABSAT.

4.3.3 Android Application Result for moving a Dish from NILESAT to ARABSAT:

Moving from NILESAT to ARABSAT indicates that the relative elevation angle must be 28.7^0 and the relative azimuth angle must be -49.04^0. Figure (4.9) Show a Serial Monitor captured image of the obtained elevation and azimuth angles for moving from NILESAT to ARABSAT that are computed and wirelessly transmitted by the Android

Application. Since the obtained angles are near to the manually computed, the user will receive a strong signal.

```
number of steps for Elevation adjustment
82
number of steps for Azimuth adjustment
-140
Relative Elevation Angle
28.70
Relative Azimuth Angle
-49.00
```

Figure (4.9): Android Application Result for moving a Dish from NILESAT to ARABSAT

4.4 System Simulation:

The Proteus 8 professional program is used for simulation and ARDUINO IDE is used for writing the basic code for moving two stepper motors. Figure (4.10) manifest the schematic capture of the positioning system. ARDUINO library is added to allow the use of ARDUINO UNO. The number of steps obtained by the serial monitor in Section (4.3) are inserted to the code for simulation. all the components used in simulation are exactly the same to the components used in the real implementation.

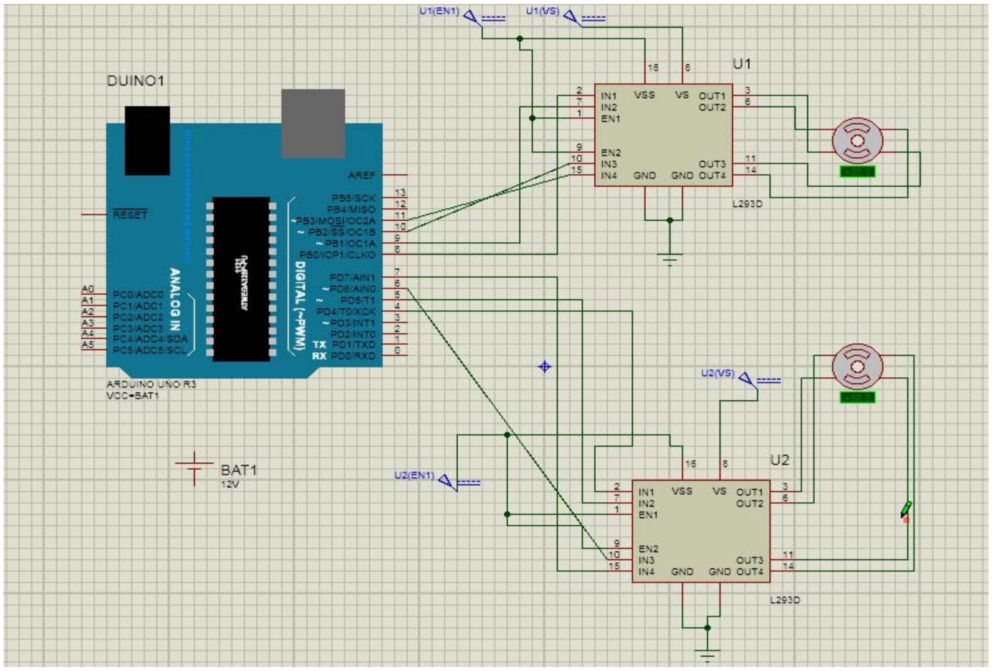

Figure (4.10): Schematic capture of the positioning system

4.4.1 Simulation result for moving from DEFAULT position to NILESAT:

Khartoum position is assumed for calculating the look angles. DEFAULT position is a truly south (180^0) and truly horizontal. For NILESAT the azimuth angle is 251.9^0 and the elevation angle is 41.5^0. Moving from DEFAULT position to NILESAT indicate the relative elevation angle is 41.5^0 and the relative azimuth angle is 71.9^0 which is obtained in the simulation illustrated in Figure(4.11).

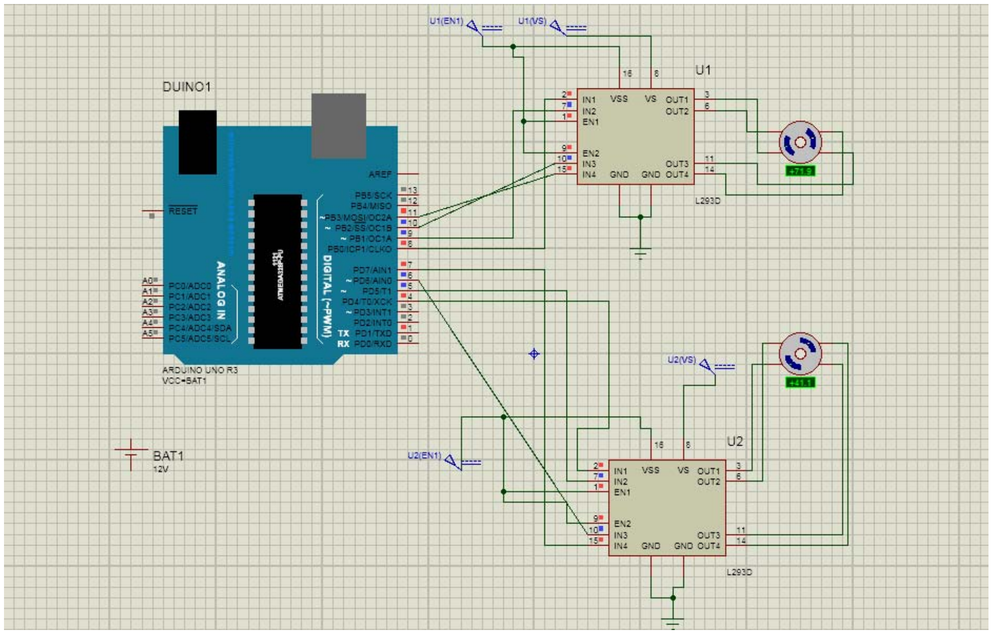

Figure (4.11): Simulation result for moving from DEFAULT position to NILESAT

4.4.2 Simulation result for moving from DEFAULT position to ARABSAT:

Khartoum position is assumed for calculating the look angles. DEFAULT position is a truly south (180^0) and truly horizontal. For ARABSAT the azimuth angle is 202.9^0 and the elevation angle is 70.2^0. Moving from DEFAULT position to ARABSAT indicate the relative elevation angle is 70.2^0 and the relative azimuth angle is 22.9^0 which is obtained in the simulation illustrated in Figure(4.12).

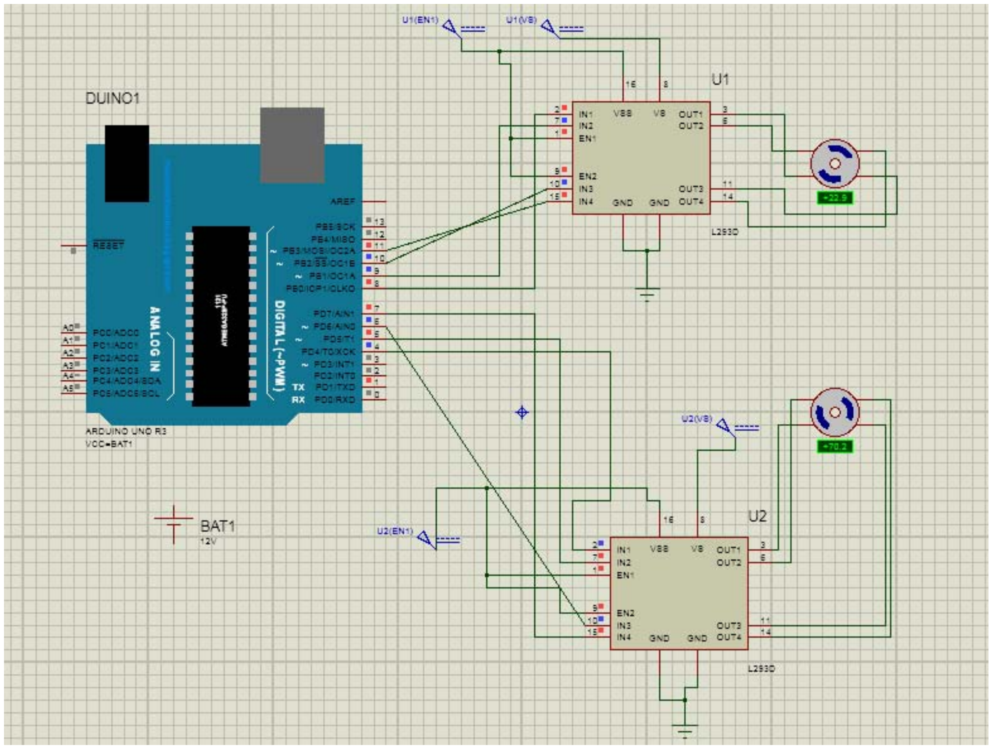

Figure (4.12): Simulation result for moving from DEFAULT position to ARABSAT

4.4.3 Simulation result for moving from NILESAT to ARABSAT:

Khartoum position is assumed for calculating the look angles. For NILESAT the azimuth angle is $251.9^0$and the elevation angle is 41.5^0. For ARABSAT the azimuth angle is 202.9^0 and the elevation angle is 70.2^0.Moving from NILESAT to ARABSAT indicate the relative elevation angle is $28.9^0$and the relative azimuth angle is -49.2^0which is obtained in the simulation illustrated in Figure(4.13).

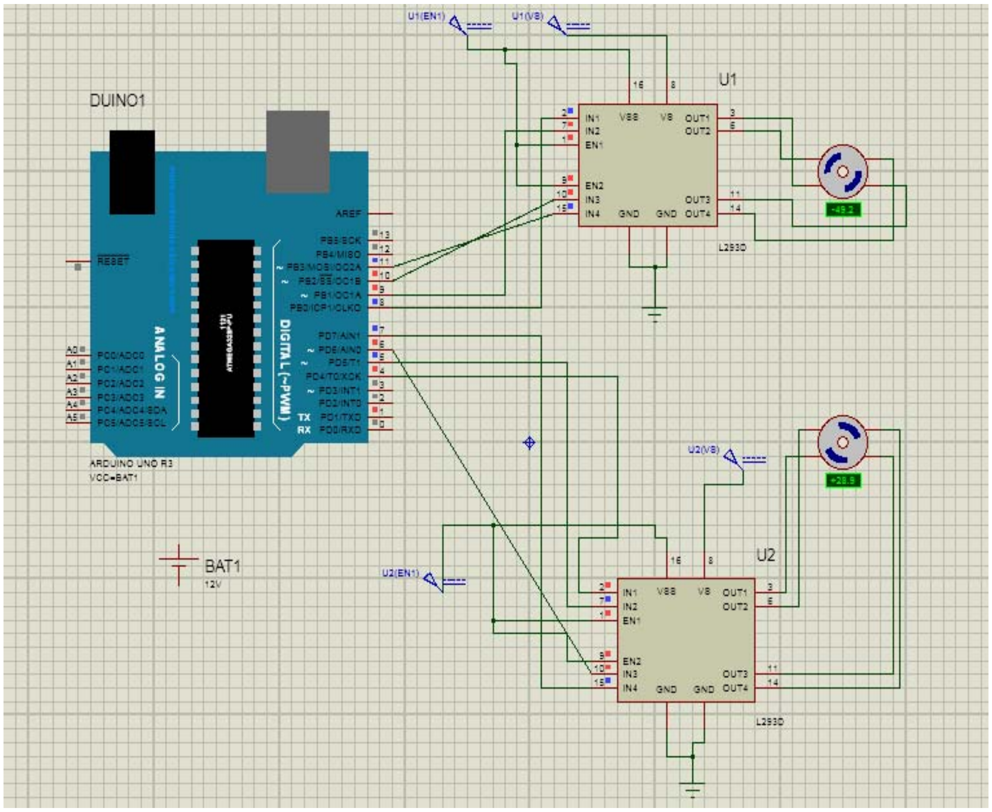

Figure (4.13): Simulation result for moving from NILESAT to ARABSAT.

4.5 System Implementation:

The system was implemented by a prototype that explain the whole idea and an android application for look angles computation. When clicking on the android application, the application will show the user all the devices that the android device is paired to as demonstrated in figure (4.14).

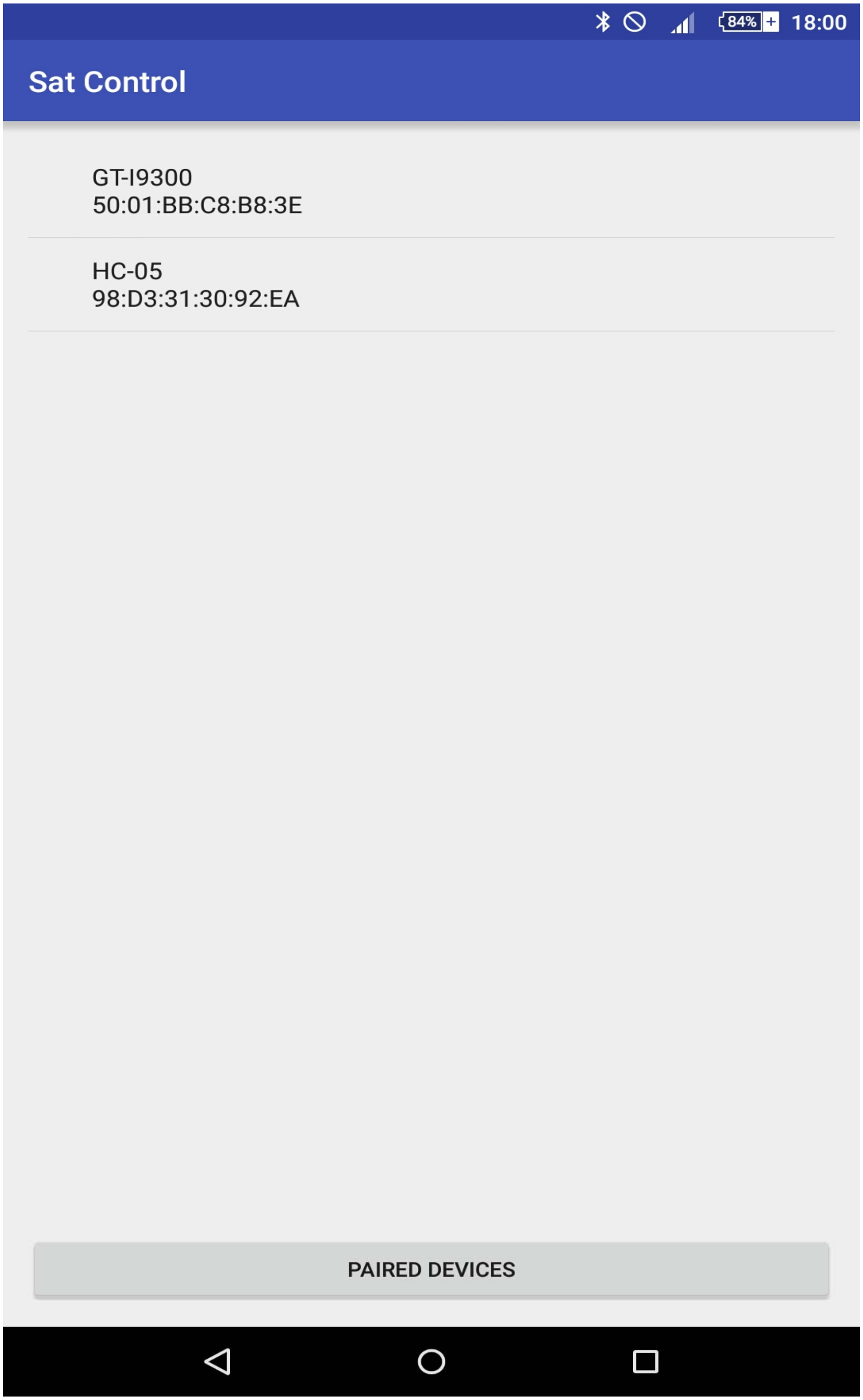

Figure (4.14): Paired devices menu.

The user must click on the name of the Bluetooth module which is generally named as HC-05 then a second window will appear and the user can select the satellite is currently receive it’s channels from a current satellite menu as illustrated in figure (4.15) .

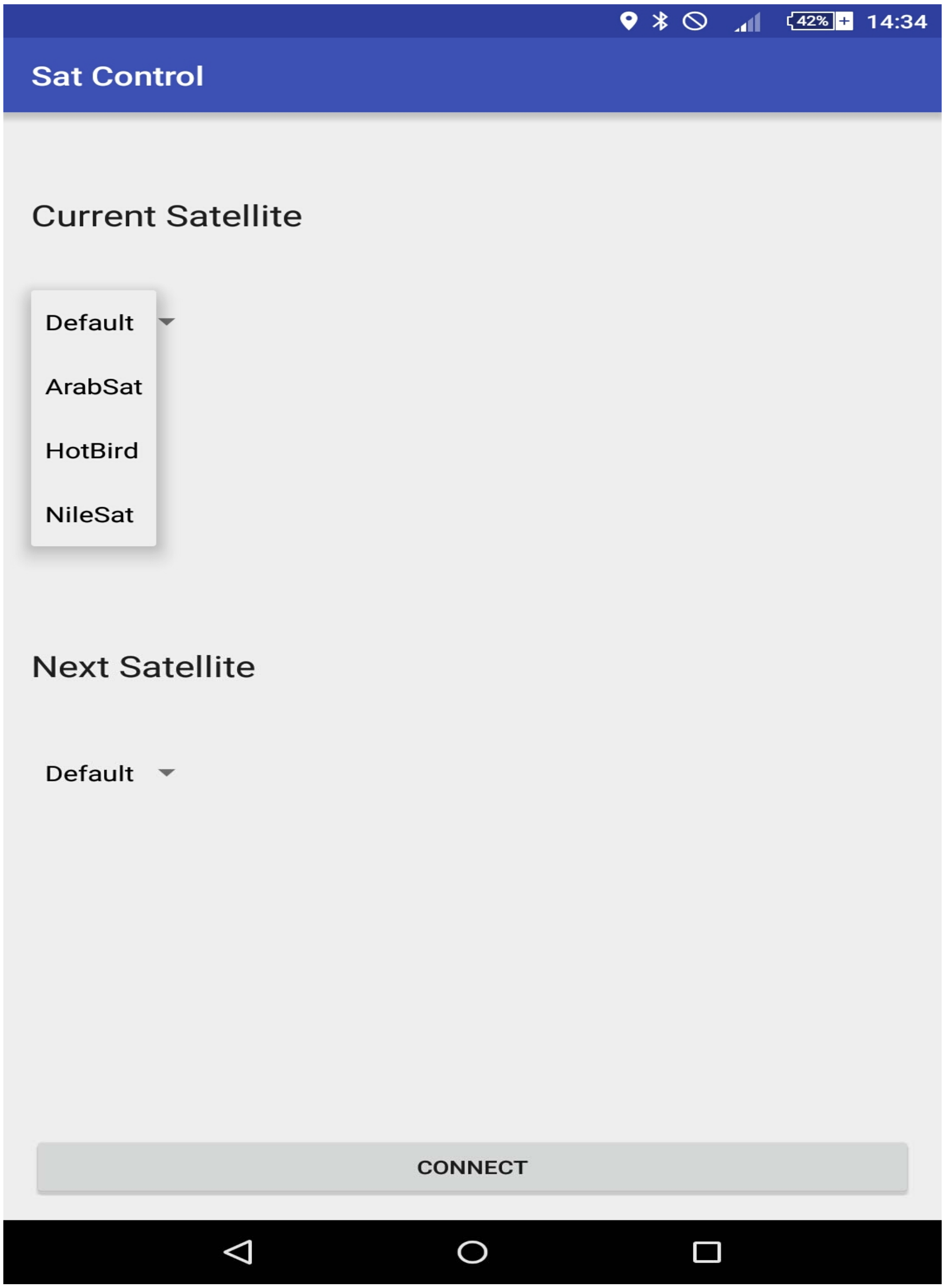

Figure (4.15): Current satellites menu.

The user then selects the desired satellite to receive its channels from a next satellite menu and finally the user must click connect button to send the computed values to the ARDUINO as illustrated in figure (4.16).

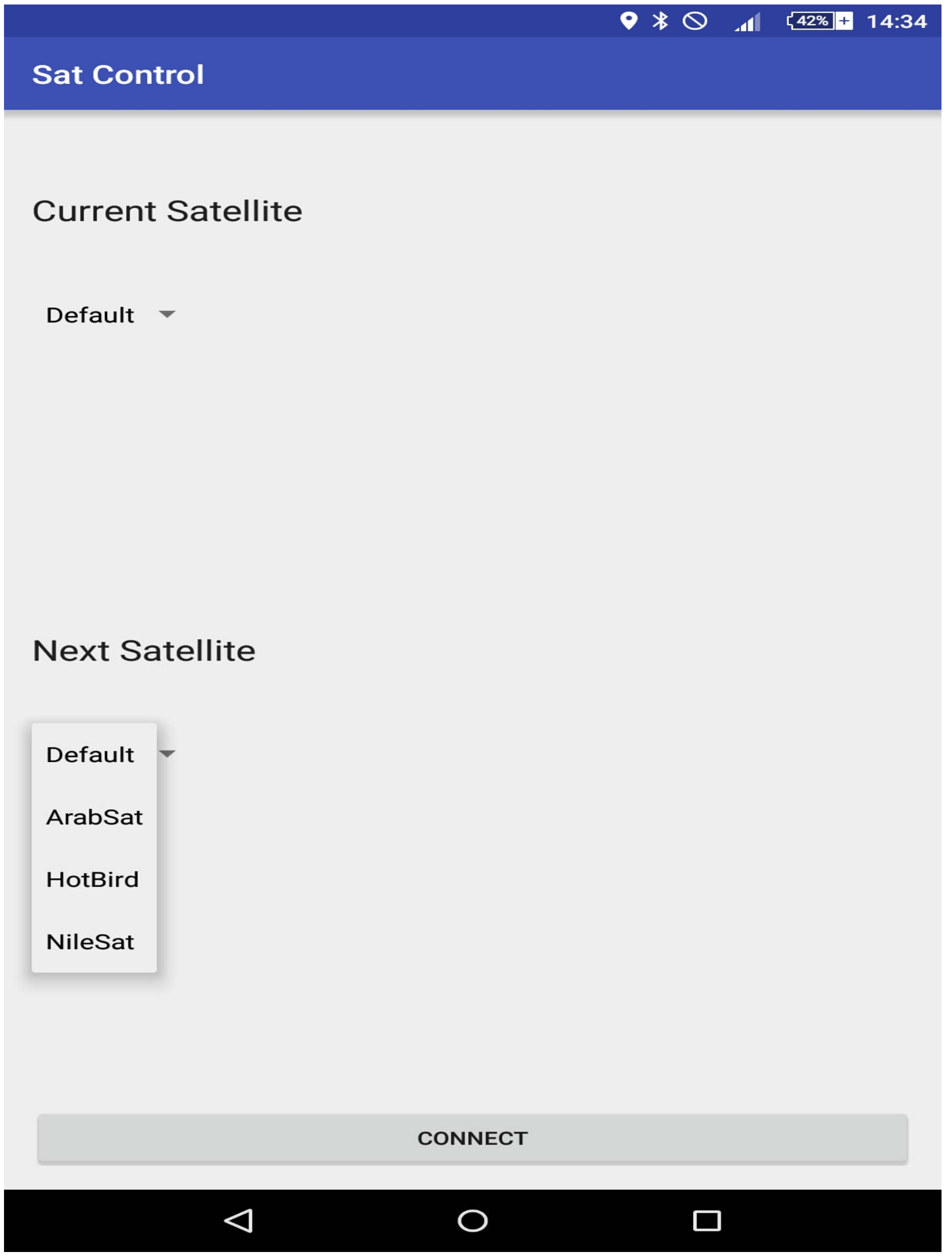

Figure (4.16): Desired satellites menu.

The system components described in section (4.2) are used not only to simulate the behavior of the system but also to implement the real system. The manmade surface-mounted motor is used to adjust the elevation angle and the ground-mounted motor used to adjust the azimuth angle. both of the motors move a CD that represent the satellite dish to the desired position. CD may be replaced by a Dish and the same motors can serve the job of aligning the look angles. Each motor can carry weight up to 18 Kg. The adapter is used for converting A.C signal of 220V to D.C signal of 12 V. Figure (4.17) show the prototype of the system.

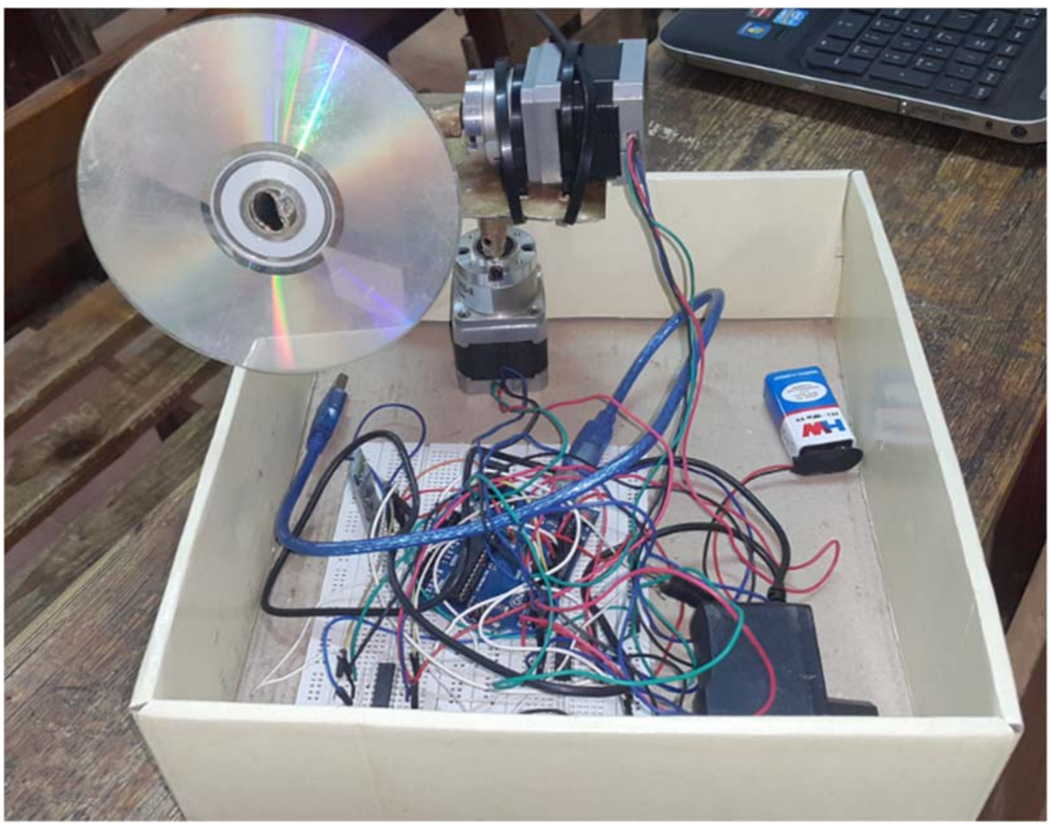

Figure (4.17): Prototype of the system.

The android application is used for moving the motors of the prototype. Motors were positioned to truly south and truly horizon as illustrated in figure (4.18)

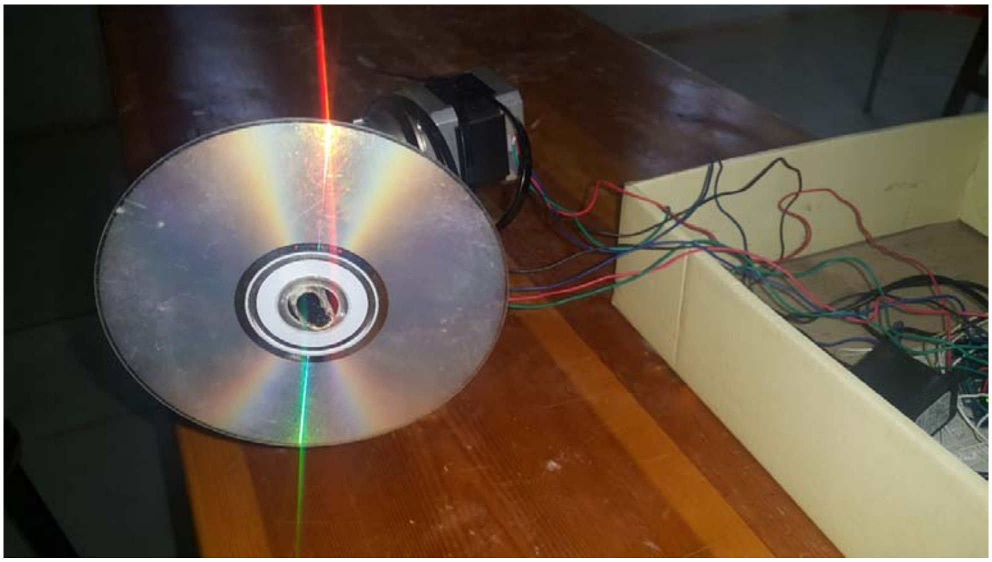

Figure (4.18): Prototype at default position.

After that android application is used to align the CD to NILESAT as illustrated in figure (4.19) .

Figure (4.19): Prototype NILESAT position.