Evaluation of Low Cost RTK GNSS System

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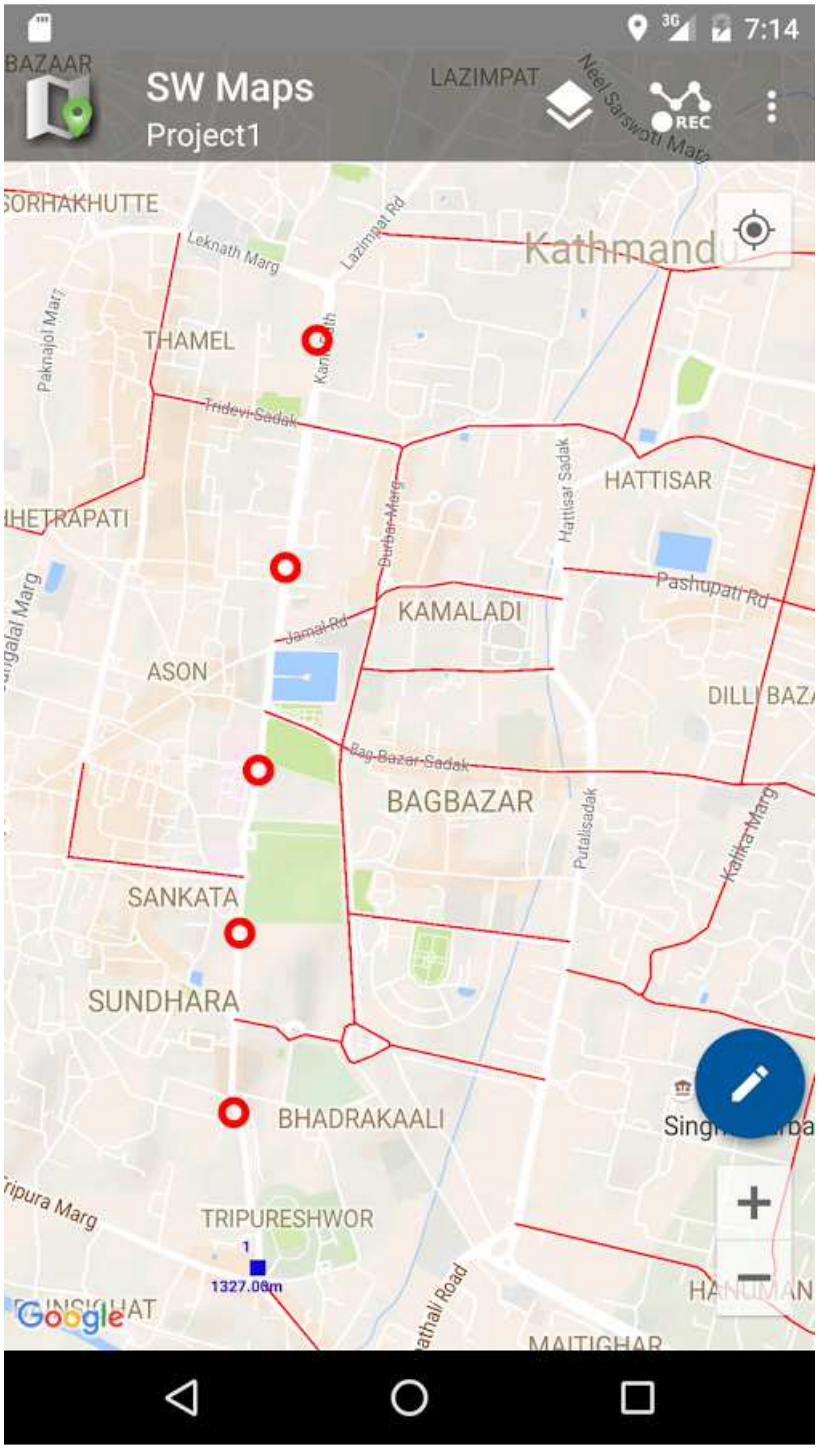
Introduction

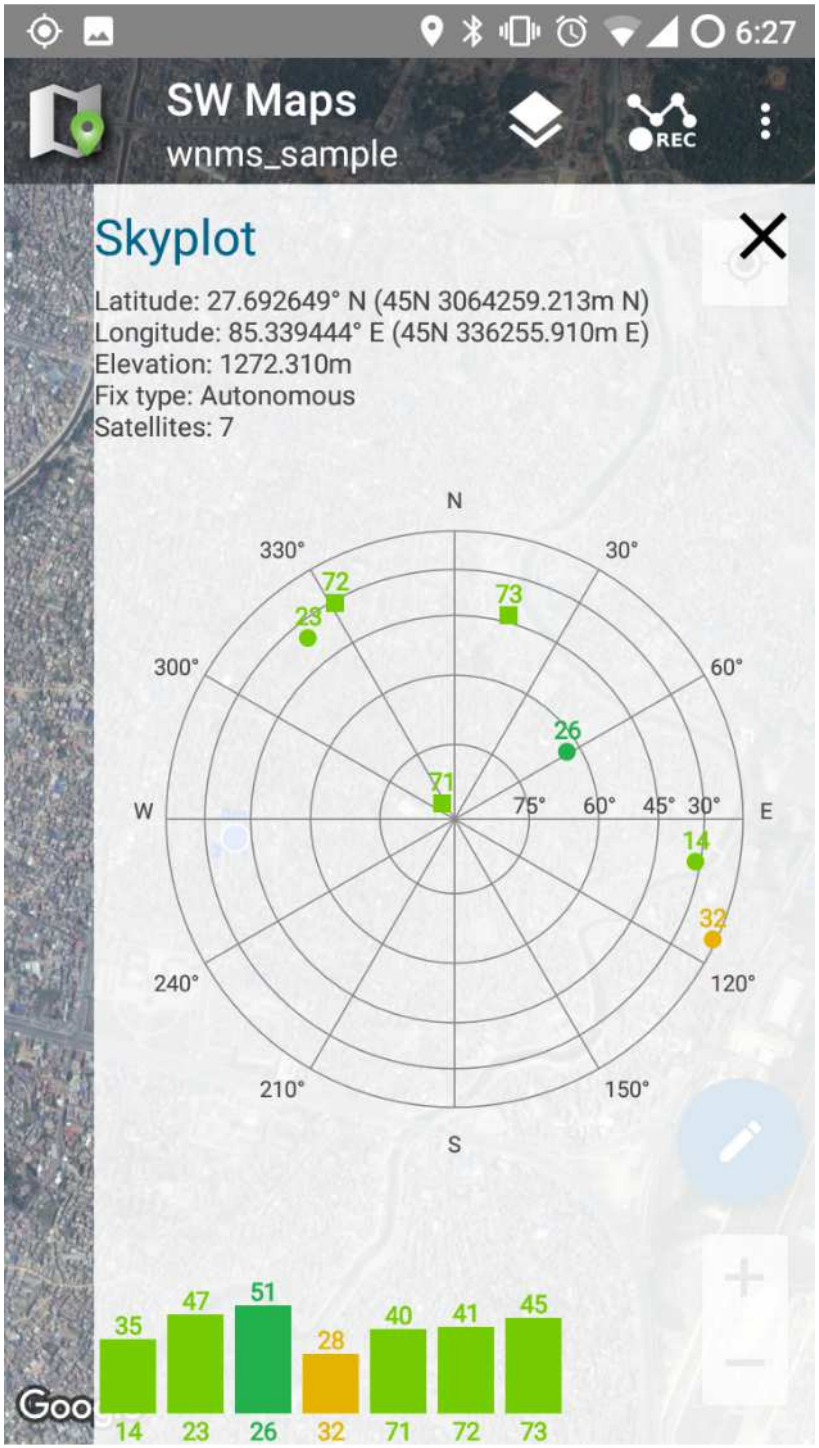
- Softwel (P) Ltd is a company dedicated in the development of engineering solutions.

- It has developed software for Digital Terrain Modeling for engineering survey works, Software for Road Design, Irrigation, water supply, sewerage and drainage, transmission lines etc and GIS customization work in ArcGIS and QGIS
- There are more than 3,000 clients including few international clients.

Background

- We have been developing **SW Maps**, a mobile mapping and field GIS application for Android. It is capable of carrying out general mapping and records features using the inbuilt GPS receivers of Android devices.
- The inbuilt GPS in current mobile devices are not sufficiently precise for most mapping tasks so the app is also capable of connecting to external, RTK capable GNSS receivers via Bluetooth.


7:14
SW Maps
Project1
LAZIMPAT
REC
Kathmandu
THAMEL
HATTISAR
KAMALADI
ASON
BAGBAZAR
SANKATA
SUNDHARA
BHADRAKAALI
TRIPURESHWOR
1327.08m
Google


6:27
SW Maps
wnms_sample
REC
Skyplot
Latitude: 27.692649° N (45N 3064259.213m N)
Longitude: 85.339444° E (45N 336255.910m E)
Elevation: 1272.310m
Fix type: Autonomous
Satellites: 7
N
E
S
W
330°
30°
300°
60°
240°
120°
210°
150°
75°
60°
45°
30°
72
23
73
26
71
14
32
35
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72
73

- High quality, dual frequency RTK receivers are far more precise in comparison to the inbuilt GPS, but also very expensive.
- These receivers are not affordable for routine works.
- A cost effective solution was needed to provide accurate RTK positioning to mobile devices.

The Low-Cost Solution

The Low-Cost Solution

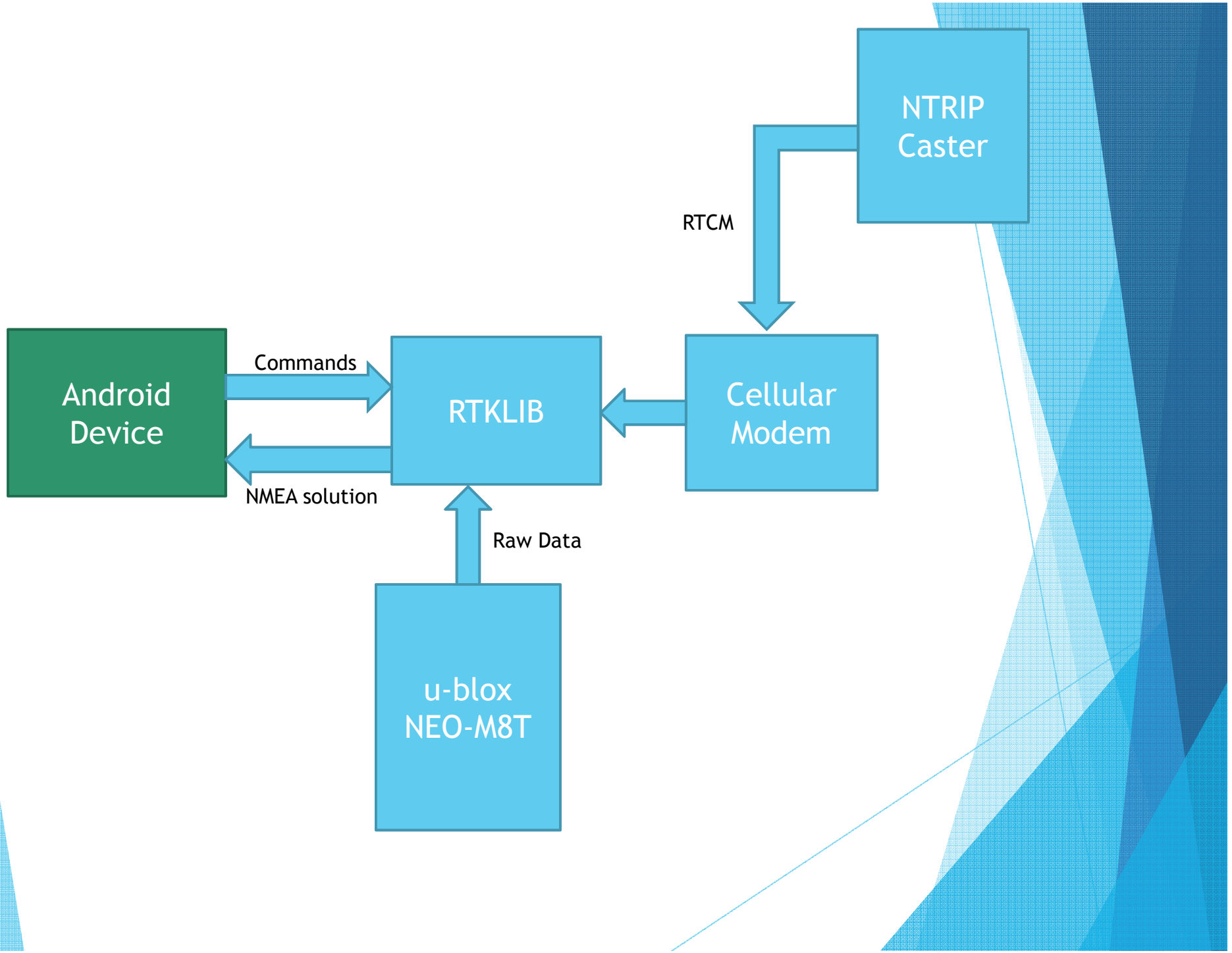
- A low-cost external GNSS receiver was built for mobile devices.

- The device uses a **u-blox NEO-M8T** receiver and the open-source program RTKLIB running on a Raspberry Pi 3 to provide RTK Positioning to a smartphone.

- The Raspberry Pi was programmed so that it can be set up using commands sent over Bluetooth using a mobile app.
- It uses a cellular modem to connect to an NTRIP caster for correction data.
- The device is powered using a regular power bank used to charge devices over USB.
- The solutions can also be recorded in the device as NMEA sentences.

RTKLIB

- *RTKLIB* is an open source program package for standard and precise positioning with GNSS.
- It consists of a portable library and several command-line based application packages, along with GUI applications for Windows only.
- For this project, RTKLIB was modified so that it can be set up using commands sent over Bluetooth.


NTRIP Caster
RTCM
Android Device
Commands
NMEA solution
RTKLIB
Cellular Modem
Raw Data
u-blox NEO-M8T

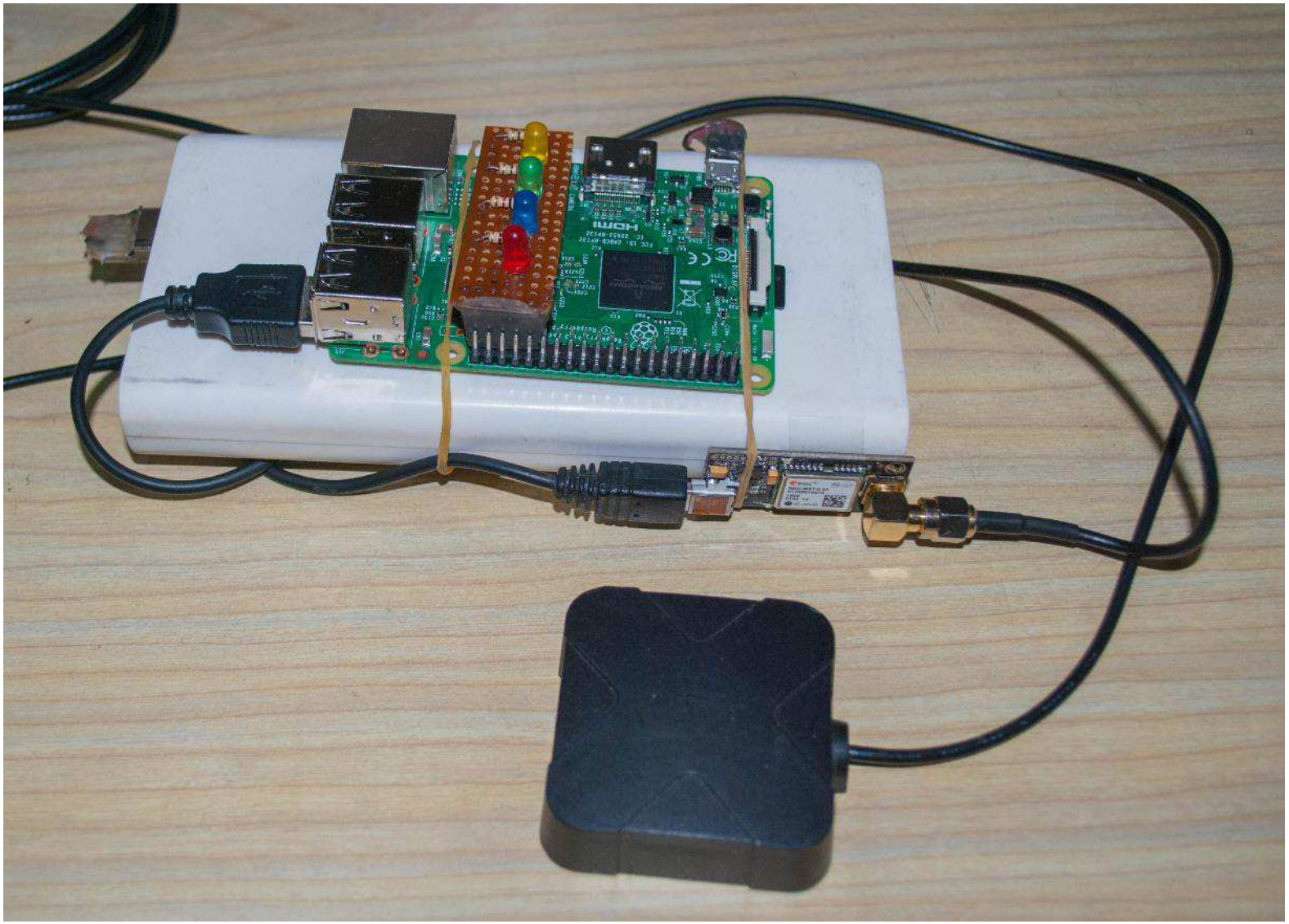
Components Used

- u-blox NEO-M8T Module
- Patch Antenna
- Raspberry Pi 3
- Power Bank (20000mAh)
- GPRS Modem

u-blox NEO-M8T

Raspberry Pi 3

Power and GPRS Modem



The Assembly

The Mobile Application

- The mobile app “RtkPi” was developed for setting up the GNSS receiver to connect to the NTRIP caster.
- The app connects to the Raspberry Pi over Bluetooth and can set it up as an RTK base station or rover.
- The app also displays current solution, satellite sky plot and SNR graph and can set the device to record NMEA sentences.

RtkPi

CONNECTION STATUS SETUP BASE SETUP ROVER

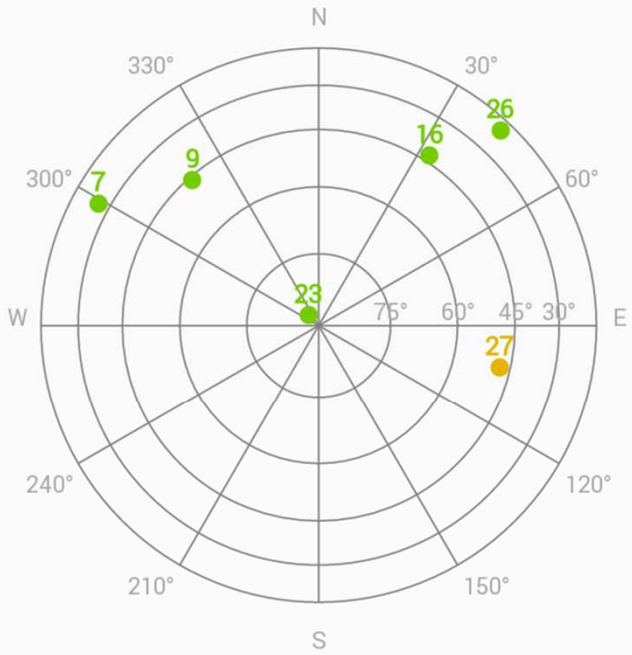
Connection

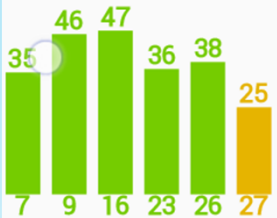
Pi-131 CONNECT

RtkPi

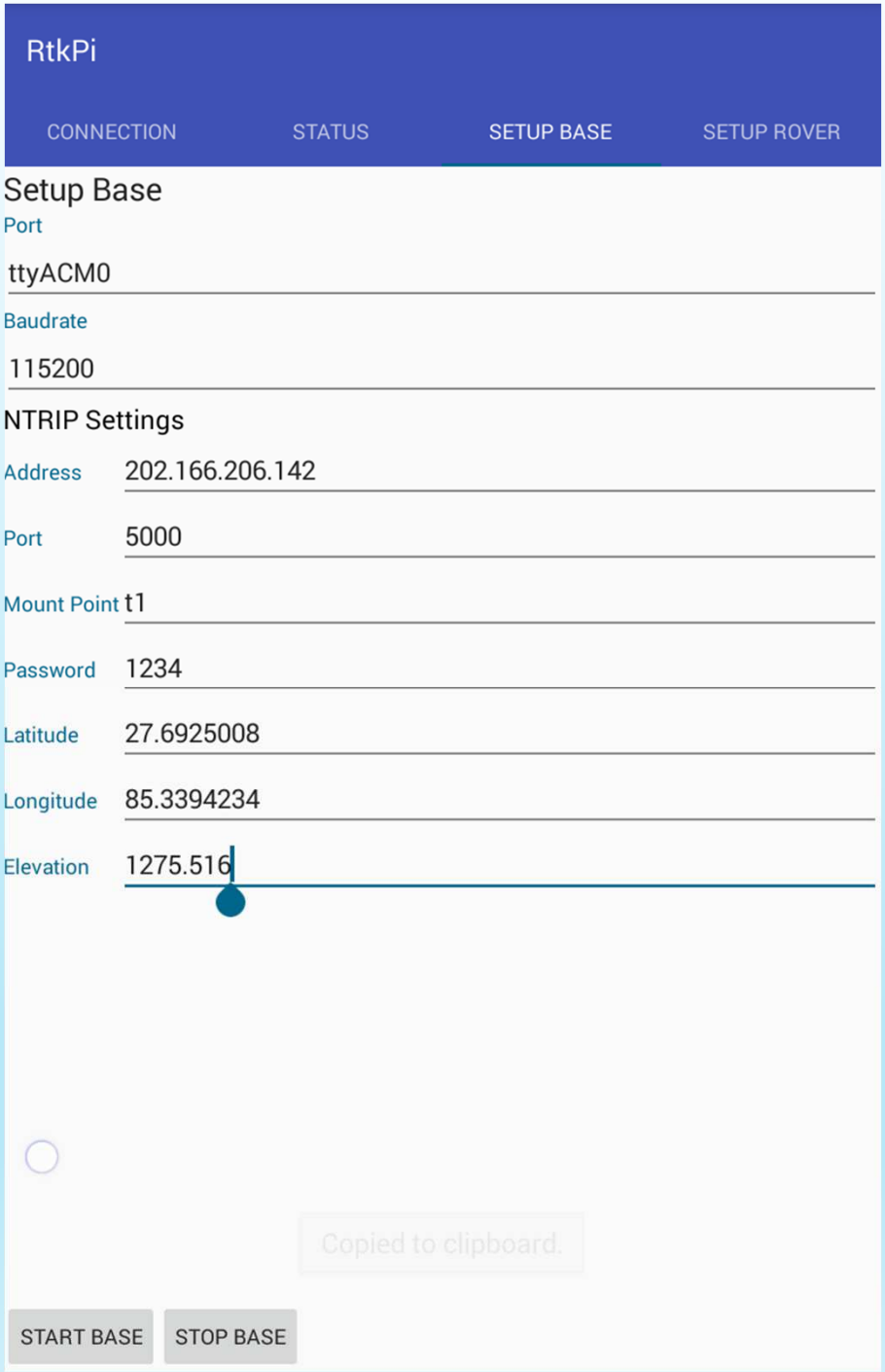
CONNECTION STATUS SETUP BASE SETUP ROVER

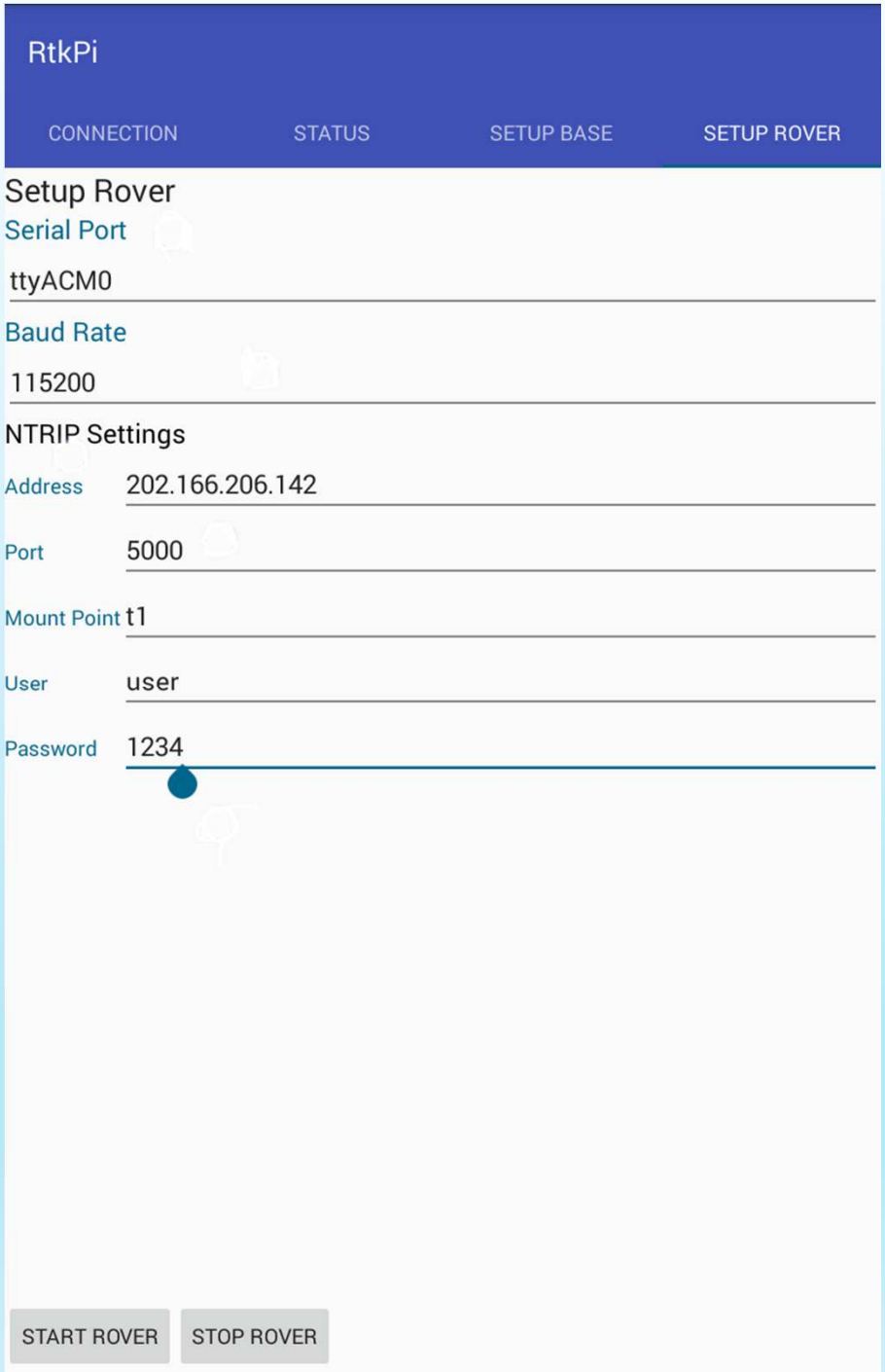
Latitude: 27.6926776
Longitude: 85.3394132
Elevation: 1274.781
Fix type: RTK Float
Satellites: 6





START RECORDING STOP RECORDING


RtkPi
CONNECTION
STATUS
SETUP BASE
SETUP ROVER
Setup Base
Port
ttyACM0
Baudrate
115200
NTRIP Settings
Address
202.166.206.142
Port
5000
Mount Point
t1
Password
1234
Latitude
27.6925008
Longitude
85.3394234
Elevation
1275.516
Copied to clipboard.
START BASE
STOP BASE


RtkPi
CONNECTION
STATUS
SETUP BASE
SETUP ROVER
Setup Rover
Serial Port
ttyACM0
Baud Rate
115200
NTRIP Settings
Address
202.166.206.142
Port
5000
Mount Point
t1
User
user
Password
1234
START ROVER
STOP ROVER

Cost

Component	Cost (NRs)*	Cost(USD)*
u-blox NEO-M8T with patch antenna	8,750	80.00
Raspberry Pi 3	3840	35.00
Power Bank (20000mAh)	3,500	32.02
GPRS Modem	2,000	18.30
Miscellaneous (LEDs, resistors, wires)	50	0.46
Total	18,140	165.78

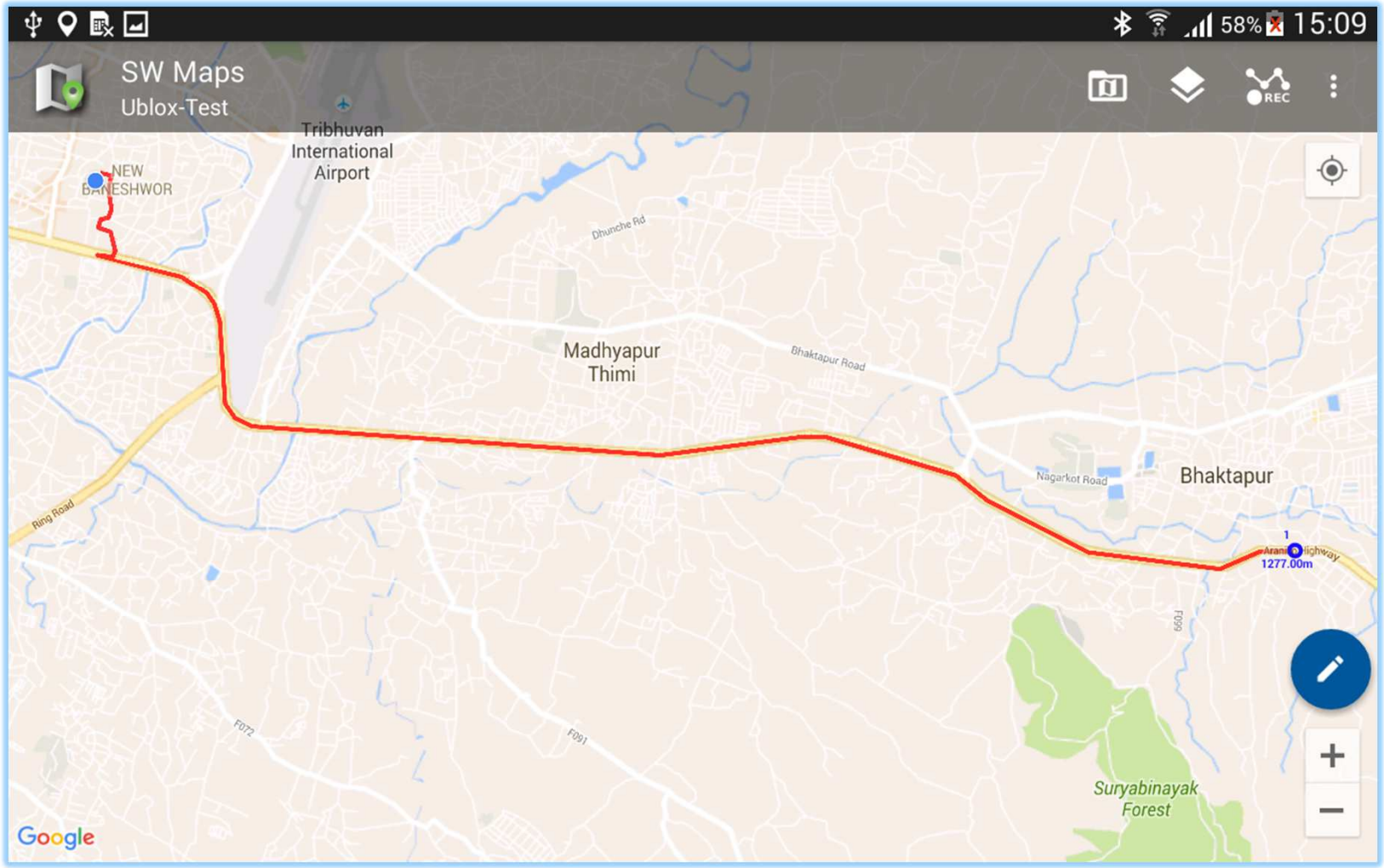
*Exchange rate 1 USD = NRs. 109.3 as of December 1, 2016

Evaluation of the system

- A base station was established using a PENTAX G3100-R1 (L/L2 receiver).
- The base station was connected to an NTRIP caster to broadcast corrections over the internet.
- The low cost receiver was then set up to connect to the caster as an RTK rover.

- Test were carried out at distance of 10 km from the base station.
- The coordinates obtained from the low-cost receiver was compared to the coordinates obtained by static post processing using another high-end receiver.

Items	X (m)	Y(m)	Ellipsoid H (m)
Static Processing with L1/L2 (20 minutes observation)	345661.794	3061245.066	1273.034
RTK With u-blox (RTK 20 Seconds Average)	345662.467	3061245.107	1275.197
Diff	0.673	0.041	2.163



Location Map

Base Station

Observation

Applications

A low-cost RTK GNSS system would unlock many new applications to GNSS that were otherwise impractical due to high cost.

- Asset Mapping including water supply pipelines, sewerage networks, manholes, electrical poles etc.
- Engineering survey works for rural water supply
- High accuracy emergency mapping
- Vehicle tracking.
- Reconnaissance surveying

Applications

The Low Cost Device can be used in conjunction with VRS system to be developed for Nepal.

Future Plans

- Re-program RTKLIB for Android supporting u-Blox M8T so that Raspberry Pi is not required which will further reduce cost per unit
- Conduct extensive testing and analysis
- Research on integration with VRS

Thank You