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Developing Geo-Tagging Application with Low Cost RTK Module

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Abstract— **The integration of Global Positioning System (GPS) and real-time kinematics (RTK) has been widely used in many applications, such as mobile mapping and autonomous vehicle control. Such applications require high-accuracy position information. However, continuous and reliable high-accuracy positioning is still challenging for GPS integration in urban environments because of the limited satellite visibility, increasing multi-path, and frequent signal blockages. Low cost GPS module has been widely used in various applications in the last few years. Low cost GPS module offers various features of global positioning system, including Standard Positioning Service (SPS), static post processed positioning and Real Time Kinematic (RTK) GPS. This project highlights the application of external low cost and high accuracy RTK GPS module for precise geo-tagging using smartphone. The Application Created by Ionic 4 and build by Android Studio. Using this Application Accurate Latitude and Longitude can be observed.**

***Index Terms*— Geotagging, RTK, Android, Low Cost, Smartphone Application.**

I. INTRODUCTION

RTK-GPS (real-time kinematic GPS) is one of the most precise positioning Technologies, with which users can obtain cm-level accuracy of the position in real-time by processing carrier-phase measurements of GPS signals. Conventionally RTK-GPS had been utilized for limited application like geodetic survey. In these days, the application of RTK-GPS has been continuously expanded to various areas like mobile mapping system, precise navigation of vehicles, construction machine control and precision agriculture. The precise positioning technology with RTK-GPS is expected to be used for much wider applications increasingly in the future[3]. For RTK-GPS, users usually need to prepare geodetic-grade receivers with firmware supporting RTK-GPS or proprietary RTK-GPS software on the receiver controller or PC provided by the receiver vendor. The receivers or such software for RTK-GPS, however, are generally still very expensive comparing to general-purpose GPS receivers.

This is one of the reasons why RTK-GPS is still not popular and is used only for limited application areas. Many peoples, who require more precise position, are longing for much lower cost RTK-GPS receivers. Since several years ago, we have developing a compact and portable software library for RTK-GPS. We refer to the library as RTKLIB, which is simply derived from "RTK library". Originally RTKLIB was intended to be used for our internal research work in order to valuate precise positioning algorithms or to provide an application platform for precise positioning system development. In the beginning, RTKLIB had only very simple function for carrier-based relative positioning and RINEX file handling for post processing. In company with several version up, a lot of useful functions and Aps (application programs) for RTK-GPS were added to RTKLIB.

RTKLIB as an open source program package under the GPLv3 license. The package of RTKLIB consists of user executable binary APs on Windows and whole source programs of the library and the APs. Users can freely download the program package, use the APs, install or link the library to the user own AP and modify the source codes according to the requirements for user applications. The latest version RTKLIB supports some consumer-grade receivers able to output raw measurement data of GPS signals. With RTKLIB and such receivers, users can construct and operate their original low-cost RTK-GPS systems. The authors have

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already evaluated RTK-GPS performance with such consumer-grade single-frequency antennas and receivers by field tests. The tests were conducted in order to clarify issues to apply low-cost receivers and antennas to RTK-GPS. As the results of these studies, we found that difference between consumer-grade receivers and geodetic-grade ones is not so large regarding to receiver performance itself. With good antennas, we can obtain cm-level accuracy of the receiver position even with such low-cost receivers. However, expensive dual-frequency receivers have an advantage of much shorter time for ambiguity resolution. With a single-frequency receiver, at least a few minutes are necessary to obtain a first fixed solution. So, in the environment with many cycle-slips like for mobile vehicle navigation, low-cost receivers are not suitable for RTK-GPS.

Though, for the application with continuous observation like crustal deformation monitoring, low-cost single-frequency receivers could be applicable for short baseline RTK-GPS. We developed a RTK-GPS receiver with RTKLIB in order to demonstrate such a low-cost RTK-GPS system and clarify the issues to implement and operate the system.

A. GPS WORKING

GPS is a tool that can detect direction and locate places in very high accuracy because it received signal from many satellites. GPS is funded by and controlled by the U. S. Department of Defense (DOD). While there are many thousands of civil users of GPS world-wide, the system was designed for and is operated by the U. S. military. GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time. Four GPS satellite signals are used to compute positions in three dimensions and the time offset in the receiver clock.

II. LITERATURE REVIEW

Geo-tagging is a fast-emerging trend in digital photography and community photo sharing. The presence of geographically relevant metadata with images and videos has opened up interesting research avenues within the multimedia and computer vision domains. In this paper, we survey geo-Tagging related research within the context of multimedia and along three dimensions: (1) Modalities in which geographical information can be Extracted, (2) Applications that can benefit from the use of geographical information, and (3) The interplay between modalities and applications. Our survey will introduce research problems and discuss significant approaches. We will discuss the nature of different modalities and lay out factors that are expected to govern the choices with respect to multimedia and vision Applications. Finally, we discuss future research directions in this field.

Geo-tagging or geo-referencing is the process of adding geographical identification metadata to various media such as images and videos in websites, blogs, or photo-sharing web-services. It can help users find a wide variety of location-specific information. For example, one can find images taken near a given location by entering latitude and longitude coordinates into a geo-tagging-enabled image search engine or just by clicking on a region in Google Map. Geo-tagging-enabled information services can also potentially be used to find location-based news, websites, or other resources. Associating time and place with pictures has always been natural for people. In the past, this association was manifested in more tangible forms such as writing the date and place where the picture was taken on the back of the print. Geotagging has generated a wave of geo-awareness in multimedia repositories and research communities alike.1,2 Yahoo Flickr has amassed about 4.7 million images and videos geotagged in the month this paper was written. Flickr allows users to provide geolocation information for their pictures either as exact or approximate geographical coordinates with the help of a map interface or as geographically relevant keywords. Geo-tagging can also be performed by using a digital camera or smart phone equipped with a GPS receiving sensor or by using a digital camera[6] that can communicate with a standalone GPS receiver (e.g., through a Bluetooth® link). Photos can also be synchronized with a GPS logging device.

III. PROPOSED SYSTEM

In the Proposed system, I intend to create a Smart combo device which contain cameras on smartphones with the addition of photo position information on photo metadata or often called geo-tagging. This is because in rig we need to identify where the well is that require extensive documentation of photographs, photo positioning information allows surveyors to recognize the location of photo objects in the survey and ease the process of data management. The Better and Faster way to improve geo-tagging position accuracy is to use an external RTK GPS module integrated with a smartphone. This paper discusses the making of Android-based smartphone applications for geo-tagging using an external RTK GPS module..

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B. ANDROID MOBILE

Android is a mobile operating system based on a modified version of the Linux kernel and other open source software, designed primarily for touchscreen mobile devices such as smartphones and tablets. Android is developed by a consortium of developers known as the Open Handset Alliance, with the main contributor and commercial marketer being Google.

Initially developed by Android Inc., which Google bought in 2005, Android was unveiled in 2007, with the first commercial Android device launched in September 2008. The current stable version is Android 10, released on September 3, 2019. The core Android source code is known as Android Open Source Project (AOSP), which is primarily licensed under the Apache License. This has allowed variants of Android to be developed on a range of other electronics, such as game consoles, digital cameras, PCs and others, each with a specialized user interface. Some well known derivatives include Android TV for televisions and Wear OS for wearables, both developed by Google.

Android's source code has been used as the basis of different ecosystems, most notably that of Google which is associated with a suite of proprietary software called Google Mobile Services (GMS), that frequently comes pre-installed on said devices. This includes core apps such as Gmail, the digital distribution platform Google Play and associated Google Play Services development platform, and usually apps such as the Google Chrome web browser. These apps are licensed by manufacturers of Android devices certified under standards imposed by Google. Other competing Android ecosystems include Amazon.com's Fire OS, or LineageOS. Software distribution is generally offered through proprietary application stores like Google Play Store or Samsung Galaxy Store, or open source platforms like Aptoide or F-Droid, which utilize software packages in the APK format.

Android has been the best-selling OS worldwide on smartphones since 2011 and on tablets since 2013. As of May 2017, it has over two billion monthly active users, the largest installed base of any operating system, and as of December 2018, the Google Play Store features over 2.6 million apps.

IV METHODOLOGY

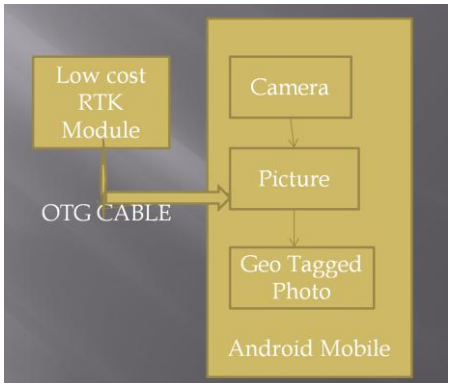
This experiment was done by integrating an external low cost RTK GPS module to an android smartphone and comparing the result of the low cost RTK geo-tagging with the standard geo-tagging using built in GPS chipset of the smartphone. GPS data from a geodetic receiver was used as reference. Research preparation's activity is mainly on setting up the external low cost RTK GPS module to the smartphone as presented. The module was connected to the smartphone via USB OTG.

Since the antenna used in the experiment is a patch antenna, Signal to Noise Ratio (SNR) constraint was set to filter the GPS signal. Signal with SNR below 30 dbHz was excluded from the observation for some issues and furthermore ready to interface from any of the remote spots which adds to general cost lessening and vitality utilization.

Pre survey was done to select suitable study area which is situated in Perumalpuram near Tirunelveli New Bus stand. Two study areas was chosen, each represent sparsely and densely populated areas. This stage includes selecting fixed location of each geotagging observation points. On each of these points, geotagging using standard built in GPS and external low cost RTK GPS was conducted sequentially. RTK observation using Geodetic GPS was also done on each of those points. Both of the RTK GPS observation was performed using NTRIP[7] services from the INDIAN CORS (INACORS).

Result analysis was emphasized on the accuracy comparison between standard geotagged photos and the low cost RTK GPS geotagged photos.

4.4 BLOCK DIAGRAM



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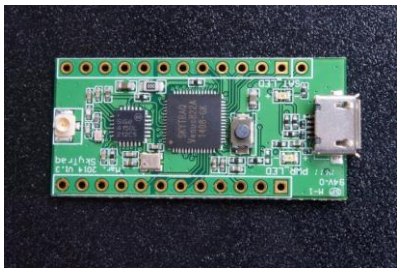
IV HARDWARE USED

This experiment was done by using equipment's and materials as follows:

- SkyTraq NS-RAW GPS module and micro strip antenna ANN-MS
- Android smartphone with USB On The Go (OTG) support and built in GPS chipset
- RaguTagging+ android app, available on google play store
- Geodetic GPS receiver
- 2G/3G/4G SIM card today, innovation has turned into a coordinated piece of individuals' lives.

SkyTraq NS-RAW GPS module



This Module is to connect the Mobile phone and RTK Module using OTG Cable

TECHNICAL SPECIFICATION:

- Support Arduino IDE (custom integration of Wiring libraries, Windows & Linux)
- GPS on board
- Breadboard compatible
- 38mm x 18mm size

HARDWARE SPECS

- 100MHz 32bit LEON3 Sparc-V8 + IEEE-754 Compliant FPU
- 1024KB Flash Memory + 212KB RAM
- ~80uA/MHz @ 3.3V
- Powered and programmed by mini USB connector
- 1 full duplex asynchronous UART
- 1 asynchronous UART transmit
- 2 SPI with master/slave mode configurable
- 1 I2C
- 1 24bit PWM
- 17 digital I/O pins (shared with above functional pins)
- Atomic clock synchronized P1PPS time reference with +/-10nsec accuracy

DESIGN FILE AVAILABILITY

NavSpark hardware design files (schematic, board design, and bill of materials) will be released and made available to users. Source code of the customized Arduino IDE will also be made available; the GPS / Beidou / GLONASS navigation kernel library integrated will remain in library file format. Users are free to extend, adapt and redistribute the hardware and software for any projects, commercial or non-commercial.

VI SOFTWARE USED

In this system, following software's are used,

1.Ionic 4 and Angular Js

2.Android Studio

3.RTK Bundle

6.1 ANDROID STUDIO

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development.

Android Studio was announced on May 16, 2013 at the Google I/O conference. It was in early access preview stage starting from version 0.1 in May 2013, then entered beta stage starting from version 0.8 which was released in June 2014. The first stable build was released in December 2014, starting from version 1.0

Since May 7, 2019, Kotlin is Google's preferred language for Android app development. Still, other

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programming languages are supported by Android Studio, such as Java and C++.

VII WORK FLOW

This application is developed by using Android Studio, based on RTK+ Android application. Instead of using RTKLIB 2.4.2 p9 (used by RTK+) who has become obsolete due to some bugs, Geo-tagging+ uses RTKLIB Demo5 b26b which is a modification of RTKLIB 2.4.3 b26. However, this version of RTKLib is not ready to be used for RTK engine and has not been complemented with unix domain socket which enables USB and bluetooth connection on Android. Hence, a modification to the to RTK+ source code was done to solve this problem This part of the work was done by using source code that is available on the website. This application is developed by using ionic 4 code and Android Studio, based on RTK+ Android application. Instead of using RTKLIB 2.4.2 p9 (used by RTK+) who has become obsolete due to some bugs, Geo-tagging+ uses RTKLIB Demo5 b26b which is a modification of RTKLIB 2.4.3 b26. However, this version of RTKLib is not ready to be used for RTK engine and has not been complemented with unix domain socket which enables USB and bluetooth connection on Android.

Hence, a modification to the to RTK+ source code was done to solve this problem This part of the work was done by using source code that is available on https://github.com/eltorio/RTKLIB.

Once the RTKLIB engine and the unix domain socket have been modified, the application is ready to be built on Android Studio software using ionic 4. Since RTKGPS+ was built using Eclipse software, it is necessary to make changes to the main folder of RTKGPS+/AndroidManifest.xml and RTKGPS+/build.gradle so that the application package can be translated by Android Studio. Program codes written in AndroidManifest.xml and build.gradle refer to [9] available on https://github.com/eltorio/RtkGps/issues/11.. Once the RTKLIB engine and the unix domain socket have been modified, the application is ready to be built on Android Studio software. Since RTKGPS+ was built using Visual Studio code software, it is necessary to make changes to the main folder of RTKGPS+/AndroidManifest.xml and RTKGPS+/build.gradle so that the application package can be translated by Android Studio. Program codes written in AndroidManifest.xml and build. gradle refer to available on https://github.com/eltorio/RtkGps/issues/

```
<ion-content>
    <ion-list>
      <ion-item>
        <h3> Lat : {{Lat}}</h3>
      </ion-item>
      <ion-item>
        <h3> Lang : {{Lang}}</h3>
      </ion-item>
      <ion-item>
        <h3> UUID : {{UUID}}</h3>
      </ion-item>
      <ion-item>
        <h3> Platform : {{Dplatform}}</h3>
      </ion-item>
      <ion-item>
        <h3> Version : {{version}}</h3>
      </ion-item>
      <ion-item>
        <h3> Manufacturer : {{manufacturer}}</h3>
      </ion-item>
    </ion-list>
    <ion-button expand="full"  (click)="onSave($event)">Map</ion-button>
    <ion-button expand="full"  (click)="onMedia($event)">Media Capture</ion-button>
    <button  ion-button color="danger" expand="full"  (click)="enableLocation()"> Location </button>
</ion-content>
```

```
import { Component } from '@angular/core';
import { HttpModule    } from '@angular/http';
import { HomeService    } from '../home.service';
import {Announcement} from '../../app/home'
import { Router } from '@angular/router';
import { Geolocation } from '@ionic-native/geolocation/ngx';
import {GoogleMaps} from '@ionic-native/google-maps';
import { Device } from '@ionic-native/device/ngx';
import { Platform } from '@ionic/angular';
import { LocationAccuracy } from '@ionic-native/location-accuracy/ngx';
import { SMS } from '@ionic-native/sms/ngx';
```

```
ngOnInit() {

  let watch = this.geolocation.watchPosition();
  watch.subscribe((watchdata) => {
   // data can be a set of coordinates, or an error (if an error occurred).
   this.Lat    = watchdata.coords.latitude;
   this.Lang   = watchdata.coords.longitude;
   this.UUID   = this.device.uuid;
   this.Dplatform   = this.device.platform;
   this.version   = this.device.version;
   this.manufacturer   =  this.device.manufacturer;

  });
```

```
  Announcements: Announcement[];
  Lat: any;
  Lang: any;
  UUID:any;
  subscription:any;
  Dplatform:any;
  version:any;
   manufacturer:any;
```

VIII RESULT

The final outcome of this project for a low cost RTK GPS Module system which can accurately analyze the GPS and embed it with the photo which is taken via the Smart Mobile. This Project is the Game changer in Rig where we

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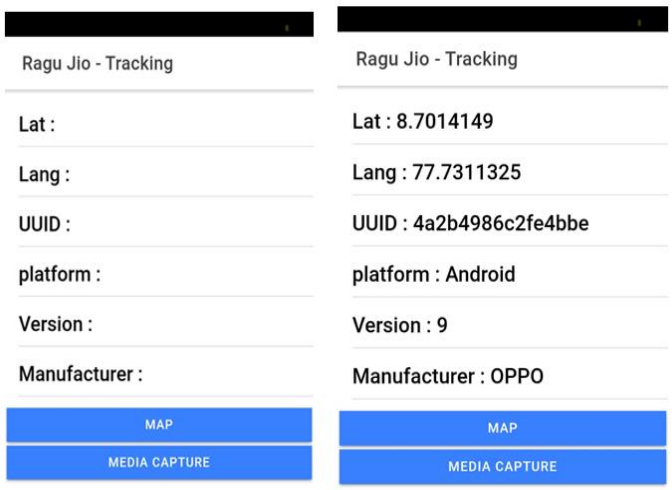
cannot find the exact location where the bore well is inside the sea. By just taking the Photo in Smart Phone the RTK GPS's Latitude and Longitude is automatically embed to the photo.



IX CONCLUSION AND FUTURE ENHANCEMENT

In this paper, we have presented the occasion of a low cost RTK GPS Module which can be used get more accurate GPS latitude and Longitude. The framework might be utilized in many spots like crime investigation, banks, healing facilities, labs and so forth that significantly reduced the danger of unapproved section. Verification might be given to the security office if any burglary issue happens. Also, the utilization of a Prediction Algorithm to anticipate the in all probability next state or occupant activity.

As the conclusion, single-based RTK GPS is capable to provide a reliable and precise data up to centimeter level accuracy.

Future enhancement

By interfacing various sorts of RTK GPS sensors to android itself, we can program the automatic GPS Embedding to all media types such as photo, video and Audio.

This could solve various crime investigation of child missing, pouching etc.

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