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Original article

Design of the Realtime GNSS Surveying Software for Advancement of Geospatial Information Construction Technology

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Abstract

Currently, start of the operation US GPS, the Russian Glonass, European Galileo, the Chinese Compass satellites for positioning are celebrating a true GNSS (Global Navigation Satellite System) generation. Korea is building advanced infrastructure such as a national network consisting of CORS (Continuously Operating Reference Station), VRS service for real-time precise positioning and perform continuous upgrading. However, the acquisition of geospatial information using the national infrastructure requires many steps and high dependence on foreign software part in this process. This study contributes to advanced construction technology of geospatial information by design of realtime GNSS surveying system. As a results, it has designed the surveying software that can effectively positioning realtime. Designed realtime surveying software can utilized in various fields.

Keywords : GNSS, Surveying Software, Realtime, Geospatial Information

1. Introduction

It began in the late 1980s, while research related to the introduction of GPS (Global Positioning System) has made a vigorous research in various fields, such as vehicle navigation, surveying, tectonic in Korea(Park *et al*., 2013a; Kwak *et al*., 2012). Korean NGII (National Geographic Information Institute) is based on the current 59 CORS (Continuously Operating Reference Station) since the reference station for the first time installed SUWN 1995 provides Network RTK (Real Time Kinematic) mode of VRS (Virtual Reference Station) services for the entire country(Hong, 2012). This was allow users to obtain the accurate position information in real time with the processing of data acquired in a short time without operating a separate reference stations(Kim and Bae, 2015; Park *et al*., 2013b).

Research into the field of Network RTK, Accuracy Analysis according to the state of reception of the satellite communication service signals and this was done. A study comparing the accuracy and satellite configuration of the network control points of the surveying results was conducted to determine the FKP (Flächen Korrektur Parameter) applicability to the public service sector surveying and cadastral surveying(Kang *et al*., 2008; No *et al*., 2012; Lee, 2013). Apply the leveling satellite surveying and analyzing the accuracy of research have also been carried out for the results. The study was done applying the multiple satellite surveying methods in various fields such as public reference point surveying, shoreline surveying(Lee and Kim, 2007; Park and Han, 2015). The availability of VRS service has proven sufficiently by existing research. But most of the research has focused on the accuracy of the surveying area using the VRS scheme, surveying research on software development is lacking. So, this Study aimed to present advanced construction technology of geospatial information by design of realtime GNSS surveying system. Fig. 1. shows study flow.

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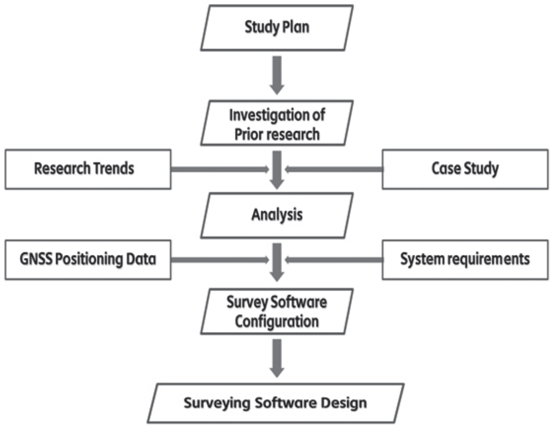

Fig. 1. Study flow

2. Software Requirements and GNSS Positionig Data

2.1 Data acquisition and processing

In this study, Investigated the software requirements for design of the realtime GNSS surveying software.

Software for real-time positioning should have a measurement, stakeout, COGO (Coordinate Geometry), site calibration capabilities, basically. COGO means a method for calculating coordinate points from surveyed bearings, distances, and angles. And the function of surveying data import and export, NTRIP (Network Transport of RTCM via Internet Protocol) for VRS service and GNSS equipment configuration is required. Fig. 2 show requirements of realtime GNSS surveying software.

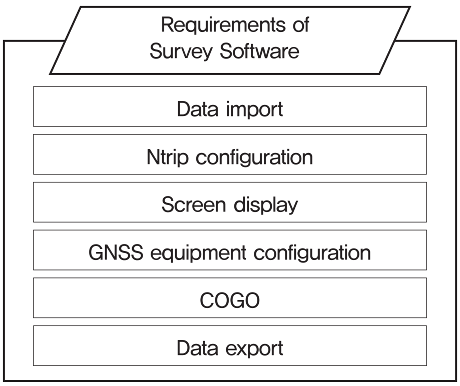

Fig. 2. Requirements of GNSS surveying software

2.2 GNSS positionig data

GNSS positioning data format from GNSS device is unique because it is manufacturer-specific format. So, general format NMEA (National Marine Electronics Association) was used for real time GNSS surveying software. NMEA has developed a specification that defines the interface between various pieces of marine electronic equipment. The standard permits marine electronics to send information to computers and to other marine equipment.

Table 1. NMEA sentences

NMEA	Description
AAM	Waypoint Arrival Alarm
ALM	Almanac data
APA	Auto Pilot A sentence
APB	Auto Pilot B sentence
BOD	Bearing Origin to Destination
BWC	Bearing using Great Circle route
DTM	Datum being used.
GGA	Fix information
GLL	Lat/Lon data
GRS	GPS Range Residuals
GSA	Overall Satellite data
GST	GPS Pseudorange Noise Statistics
GSV	Detailed Satellite data
MSK	send control for a beacon receiver
MSS	Beacon receiver status information.
RMA	recommended Loran data
RMB	recommended navigation data for gps
RMC	recommended minimum data for gps
RTE	route message
TRF	Transit Fix Data
STN	Multiple Data ID
VBW	dual Ground / Water Spped
VTG	Vector track an Speed over the Ground
WCV	Waypoint closure velocity (Velocity Made Good)
WPL	Waypoint Location information
XTC	cross track error
XTE	measured cross track error
ZTG	Zulu (UTC) time and time to go (to destination)
ZDA	Date and Time

```
$ELEXTECH, Inc G1800s
$HW Version 1.6
$SW Version 231.000.100
$Startup 4
$TOW: 0
$WK: 1192
$POS: 6378137 0 0
$Baud rate: 9600 System clock: 24.553MHz
$GPGGA,114455.532,3735.0079,N,12701.6446,E,1,03,7.9,48.8,M,19.6,M,0.0,0000*48
$GPGSA,A,2,19,25,15,,,,,,,,,,21.5,7.9,20.0*32
$GPGSV,3,1,10,03,86,244,00,19,51,218,38,16,51,057,00,07,40,048,00*77
$GPGSV,3,2,10,13,34,279,00,23,33,236,00,15,29,076,40,25,25,143,38*71
$GPGSV,3,3,10,21,18,051,,27,12,315,*77
$GPRMC,114455.532,A,3735.0079,N,12701.6446,E,0.000000,121.61,110706,,*0A
```

Fig. 3. NMEA example

There are many sentences in the NMEA standard for all kinds of devices that may be used in a marine environment. Table 1 shows NMEA sentences and Fig. 3 shows NMEA example.

Most GPS manufacturers include special messages in addition to the standard NMEA set in their products for maintenance and diagnostics purposes. Extended messages begin with "$P". In this study, GGA sentence was selected for design of realtime GNSS surveying software because the GGA sentence provides essential fix data and it is possible to view the information presented on the NMEA interface using a terminal program.

3. Design of Realtime GNSS Software

3.1 Device and coordinate system configuration

It shall be able to establish a GNSS equipment and select the coordinate system on the realtime GNSS software. Software can be configure serial port, communication baud rate etc. for communicate GNSS receiver. And the coordinate system must be user-selectable. Table 2 shows function of device configuration and Table 3 shows grid coordinate system that can be user-selectable. Grid coordinate system used GRS80 ellipsoid and calibration for local coordinate system is possible. Fig. 4 shows calibration screen.

Table 2. Function of device configuration

Item	Description
Serial Port	Com1 ~ Com20
Baud Rate	4800 ~ 24000
Data Bit	8
Stop Bit	0 ~ 1
Parity	0 ~ 1

Table 3. Grid coordinate system

Coordinate System	Latitude	Longitude	+Northing	+Easting
West	38	125	600000	200000
Middle	38	127	600000	200000
East	38	129	600000	200000
East Sea	38	131	600000	200000

Fig. 4. Calibration screen

3.2 VRS surveying

The software utilizes a NTRIP client for VRS surveying. And GGA NMEA sentence was used for realtime positioning. Fig. 5 shows code for NTRIP cliect.

In order to use this feature, user must have a connection port with a GNSS receiver. The software shows a measuring position on the computer screen using GGA sentence to be transmitted from receiver. Fig. 6 shows code for VRS surveying.

3.3 Stake out

Stake out is the ability to find the destination. First of all, the software calculates the delta value compared to the current incoming GPS coordinates to the coordinates that the user wants to measure. And than software calculates the angle for the direction indicators and displays information such as the direction of the arrow in the information display and the bottom. Fig. 7 shows code for stake out.

```
extern "C" __declspec(dllimport) void ShowNtripSet(char*,CCommThread);
void CChildFrame::OnVrsSet()
{
        vrsGGA += _T("\r\n");
        char* text = (char*)((LPCSTR)vrsGGA);
        ShowNtripSet(text,m_gpsReceiver);
        vrsGGA.Empty();
}
                                   ⋮
```

Fig. 5. Code for NTRIP client

```
void CChildFrame::OnGPSBnClickedSurvey(void)
{
  CString strPointNum,strHeight;

  double tmpX,tmpY;

  CWnd* wnd = theApp.GetMainWnd();
  CMainFrame* pMainFrame = (CMainFrame*)wnd;
  CDialogBar* pCon = &(pMainFrame->m_wndDialogBarGPS);
  CEdit *pEditName = (CEdit*)pCon->GetDlgItem(IDC_EDIT_NAME);
  BOOL bPntNameNotOverlapped;
  CString strAntHeight;
  double dAntHeight;

  GetDlgItemText(IDC_EDIT_ANTH, strAntHeight);
  dAntHeight = atof(strAntHeight);
  m_dTmpZ -=dAntHeight;
  pEditName->GetWindowText(m_strPointName);
  strHeight.Format("%f", m_dTmpZ);

                                   ⋮
```

Fig. 6. Code for VRS surveying

```
void CChildFrame::StakeOutGPS(int i)
{

   VHANDLE hLineEnt, hPointEnt1,hPointEnt2;
   VHANDLE hCurLayer = CadGetCurLayer(hDwg);
   CString str;
   double dAngle, dDist, dDX, dDY, dDZ, dDX1, dDY1;
   CadSetCurLayerByName(hDwg,_T("PTP_GPSPoint"));
   switch(i)
   {
      case 0 :
                  hLineEnt = CadAddLine
            (hDwg, m_dTmpY,m_dTmpX,m_dTmpZ,              m_StakeOutGPSDlg->m_goalY,
m_StakeOutGPSDlg->m_goalX, m_StakeOutGPSDlg->m_goalZ);

            hPointEnt1 = CadAddPoint(hDwg, m_dTmpY,m_dTmpX,m_dTmpZ);
            hPointEnt2   =   CadAddPoint(hDwg,m_StakeOutGPSDlg->m_goalY,   m_StakeOutGPSDlg->m_goalX,
m_StakeOutGPSDlg->m_goalZ);
            m_StakeOutGPSDlg->m_hLine = hLineEnt;
            m_StakeOutGPSDlg->m_hPnt1 = hPointEnt1;
            m_StakeOutGPSDlg->m_hPnt2 = hPointEnt2;
            m_StakeOutGPSDlg->m_dPrevX =m_dTmpX;
            m_StakeOutGPSDlg->m_dPrevY =m_dTmpY;


CadViewRect(hDwg,hVecWnd,m_dTmpY-50,m_dTmpX-50,m_dTmpY+50,m_dTmpX+50);
            CadUpdate(hDwg);
   dDX = m_StakeOutGPSDlg->m_goalX - (m_dTmpX);
   dDY = m_StakeOutGPSDlg->m_goalY - (m_dTmpY);
   dDZ = m_StakeOutGPSDlg->m_goalZ - m_dTmpZ;
   dDist = sqrt(dDX*dDX + dDY*dDY + dDZ*dDZ);
   dAngle = atan2(dDY,dDX);
   str.Format("%.3f", dDY);
                  m_StakeOutGPSDlg->m_editDX.SetWindowText(_T(str));
                  str.Format("%.3f", dDX);
                  m_StakeOutGPSDlg->m_editDY.SetWindowText(_T(str));
                  str.Format("%.3f", dDZ);
                  m_StakeOutGPSDlg->m_editDZ.SetWindowText(_T(str));
                  str.Format("%.3f", dDist);
                  m_StakeOutGPSDlg->m_editDist.SetWindowText(_T(str));
                  SetTimer(2,m_StakeOutGPSDlg->m_iSelPeriod,NULL);
            break;
            }
            CadSetCurLayer(hDwg,hCurLayer);
}
                                    ⋮
```

Fig. 7. Code for stake out

As a results, it has designed the surveying software that can effectively positioning realtime. Real-Time Surveying VRS software it is possible to surveying and stake out. If the realtime GNSS positioning software is implemented, it can utilized in various surveying fields.

4. Conclusion

In this study, This study contributes to advanced construction technology of geospatial information by design of realtime GNSS surveying system. The conclusions were followings.

1. It has designed the surveying software that can effectively positioning realtime using VRS surveying and stake out through the investigation of the case studies and NMEA format.
2. If the realtime GNSS positioning software is implemented, it contributes to advanced construction technology of geospatial information.
3. The realtime GNSS software can utilized in various surveying fields such as public surveying, cadastral surveying and so on.

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