接触により拡大することをふまえ、流行の時空間モデルを構築する。ここでは、感受性人口を S、感染人口を I、さらに感染後に死亡、もしくは免疫を獲得した人の数である隔離人口を R とする。

まず、地域が単一のものとして存在し、他の地域の影響を全く受けない、つまり外から閉ざされた状況では、時刻 t における感受性者数 $S(t)$、感染者数 $I(t)$、隔離人口 $R(t)$の時間的推移は、古典的な SIR モデルによると、感受性者と感染者の接触の程度を示す感染率 β、および隔離率 δ を用いて、以下の微分方程式のように表される（ギセック，2006）。

$$\begin{cases} \dfrac{dS(t)}{dt} = -\beta \cdot S(t) \cdot I(t), & (1) \\ \dfrac{dI(t)}{dt} = \beta \cdot S(t) \cdot I(t) - \delta \cdot I(t), & (2) \\ \dfrac{dR(t)}{dt} = \delta \cdot I(t) & (3) \end{cases}$$

さらに、(1)～(3)式を離散化することにより、次のような差分方程式に書き換える。

$$\begin{cases} S(t+1) = S(t) - \beta \cdot S(t) \cdot I(t), & (4) \\ I(t+1) = I(t) + \beta \cdot S(t) \cdot I(t) - \delta \cdot I(t), & (5) \\ R(t+1) = R(t) + \delta \cdot I(t) & (6) \end{cases}$$

上記の SIR モデルは単一の地域内の流行現象を記述するものであるが、現実には地域間において、それぞれ流行に影響を及ぼし合っている。特に、小学校区という小さい地域単位で流行を考えるにあたり、他地域の影響は決して無視できないとともに、元来、感染症が人と人の間の接触によって起こることを考えれば、流行において他地域の考慮は必然である。

そこで本研究では、流行の過程を把握するために、各地域間の影響に着目したインフルエンザの流行モデルを検討する。地域間の影響度は、人の移動量にもとづく接触の程度などにより、各地域間で不均一であると考えられる（図 1）。

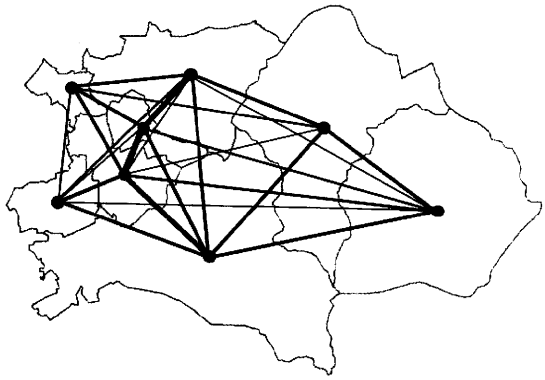

図 1　地域間によって異なる影響度

以上をふまえ、(4)～(6)式からさらに、地域 i の流行推移に対して影響を及ぼす、地域 j の感染者数の存在を考慮した、時空間的流行モデルを本分析において構築する。地域間の影響度は、互いの接触の程度を表すものであるから、地域間の移動量に依存する量であると考えられる。地域間の移動量には、パーソントリップ調査のトリップエンドの集計数を用いることとする。以上より、流行の変化が地域内と地域外の影響によるものとし、地域 i における感受性人口 $S(t)$、感染人口 $I(t)$、隔離人口 $R(t)$の時間的推移を、以下の(7)～(9)式のように表す。

$$\begin{cases} S_i(t+1) - S_i(t) = -\alpha_i \cdot S_i(t) \cdot I_i(t) \\ \qquad - \sum_{j \neq i} \beta_i F_{i \leftrightarrow j}^{\gamma} \cdot S_i(t) \cdot I_j(t), & (7) \\ I_i(t+1) - I_i(t) = \alpha_i \cdot S_i(t) \cdot I_i(t) \\ \qquad + \sum_{j \neq i} \beta_i F_{i \leftrightarrow j}^{\gamma} \cdot S_i(t) \cdot I_j(t) - \delta \cdot I_i(t), & (8) \\ R_i(t+1) - R_i(t) = \delta \cdot I_i(t) & (9) \end{cases}$$

α_i : 地域iの地域内影響パラ－メータ
β_i: 地域iの地域外影響パラ－メータ
γ: 移動量パラ－メータ
δ: 隔離パラ－メータ
$S_i(t)$: 時刻tにおける感受性人口
$I_i(t)$: 時刻tにおける感染人口
$R_i(t)$: 時刻tにおける隔離人口
$F_{i \leftrightarrow j}$: 地域iと地域jの間の双方向トリップ数

C．研究結果

宮城県仙台市の2010年10月から2011年3月までの全小学校欠席数の推移を図2に示す。グラフが一部不連続になっているのは、11月および2月の祝日、さらに冬休みのためである。

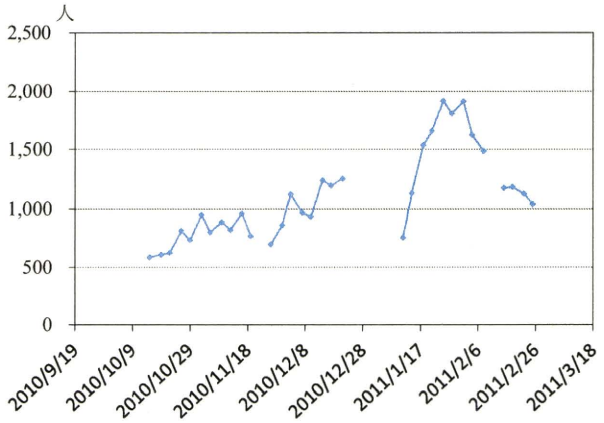

図2　仙台市全小学校の欠席数推移

さらに、小学校区別の欠席数変化の一覧を、図3に示す。ただし、グラフの縦方向については、各小学校で欠席数の最大値を上限として基準化されているため、絶対数を表してはいない。

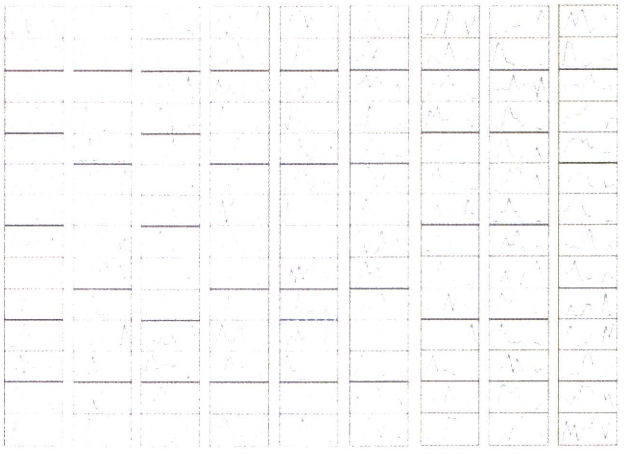

図3　仙台市全小学校の欠席数推移

D．考察

図2の欠席数全体の時間的変化を見ると、1月以降に流行のピークが現れていることが確認できる。また、前年度である2009年度に流行した新型インフルエンザの影響もあるとはいえ、1月以降の推移は比較的単純な流行曲線となっていると言える。

その一方で、図3の小学校区別の欠席数変化では、欠席数の時間的変化が複雑なものが多く、特に規模の小さい小学校においては、母集団に対して不安定な値となるため、変動が大きくなる傾向にあると言える。欠席数の時間的変化については、空間的な相関も含めて、パターンの類似性にもとづいた分類をおこなうことで、将来的な予測につながる時間的変化の特徴を見出すことも可能であると考えられる。

図4は、本研究において作成し、仙台市衛生研究所から公開されている、各小学校単位の欠席率を用いたインフルエンザ流行マップである。原則として調査日から数日以内に更新されることから、最近の流行状況を地図上で容易に理解することができる。

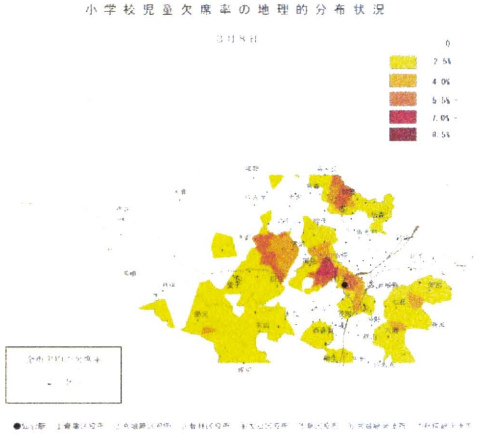

図4　仙台市HPの欠席率状況図(2011年3月8日)

また、流行モデルにおいて、地域間の影響度として用いるパーソントリップ調査のデータ集計単位は、仙台市内が244ゾーンに分割された中ゾーンとしたことから、流行分析に用いる126校区に対して十分な精度であると言える。ただ、この中ゾーンは、町丁・字等とも、小学校区とも境界が一致しないため、今後中ゾーンの境界データを新たに作成し、

中ゾーンと小学校区の領域の重なりの程度により、校区間のトリップエンド数を求める必要がある。

E. 結論

地域健康危機管理においては、健康危機事象の時間的および空間的な把握が重要であり、実データを用いた分析モデルの構築は、健康被害の拡大抑止のための有効な手段となる。

感染症の流行においては、地域間の影響は無視できない要素であり、地域間の人の移動量を考慮した分析は意義が高い。

F. 研究発表

1. 論文発表

特になし

2. 学会発表

片岡裕介, 浅見泰司, 浅利靖, 郡山一明 (2010) 「心停止発生地点に着目した AED の最適配置」, 第 46 回日本循環器病予防学会・日本循環器管理研究協議会総会.

G. 知的財産権の出願・登録状況

特になし

謝辞

東京大学空間情報科学研究センターの研究用空間データ利用を伴う共同研究として、以下のデータを利用した。

(株) ゼンリン提供：ZmapTownII (shape 版) 宮城県 データセット

また、仙台市都市整備局より、第 4 回仙台都市圏パーソントリップ調査 (2002 年実施) のデータを提供いただいた。

記して謝意を表する。

参考文献

ヨハン・ギセック (山本太郎, 門司和彦 (訳)) (2006)『感染症疫学：感染性の計測・数学モデル・流行の構造』昭和堂

厚生労働科学研究費補助金（健康安全・危機管理対策総合研究事業）
分担研究報告書

学校欠席状況は地域の感染症サーベイランスとして有用か？
― 2009年新型インフルエンザによる検証 ―

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研究要旨
これまで我々は、地域の感染症発生と拡大状況を学校の欠席状況で把握できる可能性を見出してきた。これまで構築してきた理論と方法を2009年の新型インフルエンザを対象として検証した。
その結果、学校欠席状況は地域の感染症罹患状況を把握している要素が大きいと考えられた。感染症発生と拡大状況把握に学校欠席状況は有用であると考えられた。

A．研究目的

これまで我々は、感染症の地域発生、及び拡大を小学校欠席状況に着目して分析できないかと試みてきた。 小学校は地域毎に相当数が存在し、毎日一定数の児童が継続的に登校してくる。そして在籍児童が健康被害に陥った場合には、その原因が感染症であれ化学物質であれ、欠席という形で反映されるからである。

過去に地域で流行した新興感染症であるクリプトスポリジウム事例では、小学校欠席状況がサーベイランスとして実用性があることを見出し、季節性インフルエンザでも、その可能性があることを示してきた。

さらに、実際の生活空間には山や海などの人々が生活してない、すなわちヒト―ヒト感染の拡大場とはなりえない空間が存在する。これを考慮して、地形図と生活空間とのマッチングを行って「地形を考慮した」うえで、小学校欠席状況をクリギング法で空間補間して地図を作成する方法を示してきた。

2009年には、ブタインフルエンザがヒトへの感染性を獲得して新型インフルエンザとなり、世界各地で流行した。日本においても4月に流入して8月には全国各地で流行した。医師によって新型インフルエンザと診断された場合には、保護者を通じて学校に連絡され、学校は報告された事例をすべてを把握することとされた。一時的ではあれ、欠席理由と欠席状況を1対1に対応させることが可能な状況が構築されたのである。我々が、これまで行ってきた方法を検証できる条件が整った。

そこで、新型インフルエンザを対象に、地域発生状況。及び拡大状況を学校の欠席状況で把握可能か否かを検証することとした。

B．研究方法

1．対象と学校

仙台市の市立小学校 124 校、市立中学校 65 校を対象とした。

2．調査方法と調査期間

それぞれの学校毎のインフルエンザによる欠席者数を調べた。

調査期間は2009年8月29日から11

月10日までの毎週火曜と金曜とした。

3. 解析方法

学校毎の欠席者数をそれぞれの在籍者数で除し、欠席率を算出した。三次元の座標を設定し、x軸上に小学校の経度、y軸上に小学校の緯度を入力し、z軸上に欠席率を入力した。地形図において山、海が存在する空間は生活空間となりえないため、山、海の座標を設定し、そのz軸上に−0.01を入力した。
これらの値をクリギング法を用いて空間補間し、地図上に視覚化した。視覚化の際には、インフルエンザによる欠席率が0.5%以上を図示した。空間補間及び視覚化にはサーファー8のソフトを用いた。

C．研究結果

小、中学校の新型インフルエンザ欠席状況をクリギング化したものを図で示す。
夏休みが終了し、2学期が始まった8月29日には既に小学、中学校ともに新型インフルエンザによる欠席者数が在校生の 0.5%以上の学校が存在していた（図1）。

小学校、中学校ともにインフルエンザが発生した地域は仙台市中央であり（図1）、9月8日までは小、中学校ともに同地域内で欠席状況が高くなっていった（図2，3、4）。

9月11日には市中心部に加えて市西部の小学校で欠席状況が高い学校が出現し、15日には同地域内の小、中学校ともに欠席状況が高くなっていった(図5，6、7)。

その後、新型インフルエンザは次第に市内全域に拡大し、10月後半からは小、中学校ともに爆発的に欠席率が上昇していった（図8、9，10)。

D．考察

我々は、これまで、地域に相当数存在しており、年齢層も一定であることを理由として、学校欠席状況は健康危機管理のサーベイランス方法として有用であるとの認識を示してきた[1)]。この場合、在籍者数のよる分母の違い、不登校による学校間較差をなくすために「標準化欠席比」を用いることなどを提案してきた[2)]。今回は日常の欠席状況が不明であり「標準化欠席比」を用いることができなかったが、新型インフルエンザが一時的に全数把握感染症となり小、中学校全てにおいて把握されたことから不登校の問題は解消されており、また他の疾患による欠席は含まないことから、サーベイランスの精度は非常に高いと言える。

学校の欠席状況が地域の感染症サーベイランスとして使用できるためには、学校の欠席状況が地域の感染症発生、及び拡大と相関していることが必須である。学校の欠席状況が高い場合、その理由には、①当該学校だけに感染症が流行している場合、②地域で感染症が流行しておりそれが欠席状況に反映されている場合、の2つがあるだろう。我々は、学校欠席状況が感染症サーベイランスとして有用であることを提言しつつも、常に払拭できなかったのは①の場合である。もちろん、この場合でもネットワーク理論で考えれば、学校は媒介中心性が高いので、学校内だけで感染症が流行している場合でも、地域で拡大する前兆であることは間違いない。しかし、①に加えて確かに②が存在することを示す必要もある。

今回の研究は、②についての検証である。すなわち、学校欠席状況が地域の感染状況が反映されたものであれば、同一地域内の小学校と中学校の欠席状況には相似性があるはずだ。

その結果、8月29日から9月上旬までは、小、中学校ともに市の中心部で欠席状況が高いことが示された。これは②に相当するものと解釈できる。また、9月8日に示された市西部での小学校欠

席状況の高さは、9月11日には当該小学校以外には及んでいないが、9月15日には同地域の中学校でも示され18日も小、中学校ともに高くなっていた。9月8日段階では単独小学校内で感染拡大していたインフルエンザが、家庭を通じて地域に拡大していったのを反映しているのかもしれない。まさに地域拡大の前兆である可能性が高い。

いずれの結果も、地域における感染症拡大と相関しており、学校欠席状況は地域における感染症の発生、拡大のサーベイランスとして有用であることが検証された。

感染拡大抑制には、感染者対策とともに、地域において伝染に際してハブとなっている場所を見出し対応することが有効であるとの指摘がある。そのためには感染者の把握に加えて、ハブ化している空間を把握する方法を開発する必要性がある。9月8日からの西部地域での変化は、前述したように小学校がハブ機能を果たしていることを示唆する所見と捉えることも可能であり、本方法はこれに対応できる方法のひとつであると考える。

今回は欠席状況をクリギング化して、カットオフ化したものを図示したが、カットオフ値の決め方が問題であろう。今後は地域内の小。中学校の欠席率そのものを対比させることで、両学校の相似性をさらに詳細に検討する予定である。

E．結論

学校欠席状況は地域の感染症発生、及び拡大を把握するためのサーベイランスとして有用である。

F．研究発表

1．　論文発表

特になし

2．　学会発表

郡山一明　王子野麻代
感染症のリスクコミュニケーション
平成23年1月21日　安全・安心研究会

G．知的財産権の出願・登録状況

特になし

参考文献

1．健康危機管理と小学校欠席状況サーベイランス
郡山一明、片岡祐介、竹中ゆかり、浅見泰司、高橋邦彦、丹後俊郎
保健医療科学　57（2）．
130－136：2008

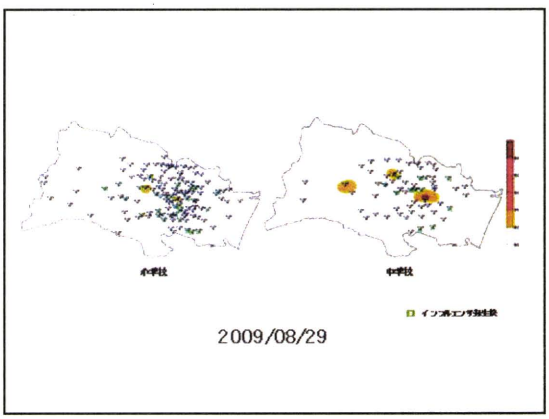

図1　8月29日の小、中学校の欠席状況クリギング図

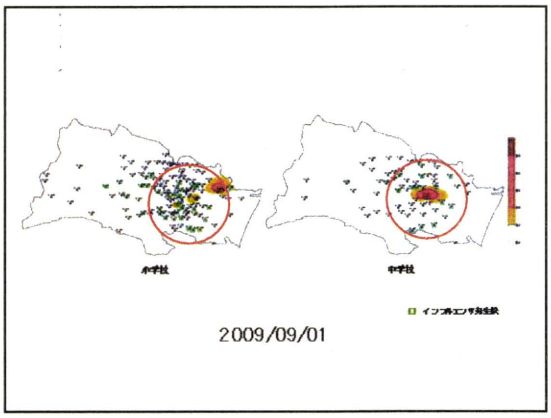

図2　9月1日の小、中学校の欠席状況クリギング図

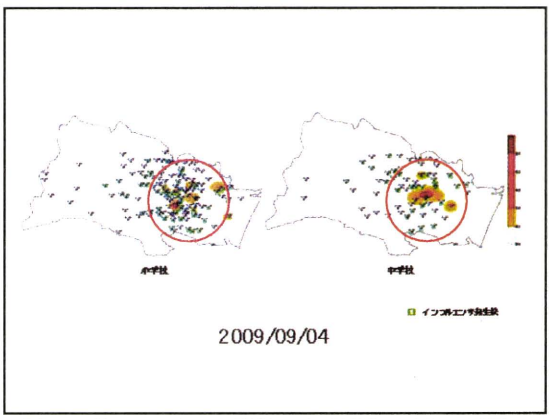

図3　9月4日の小、中学校の欠席状況クリギング図

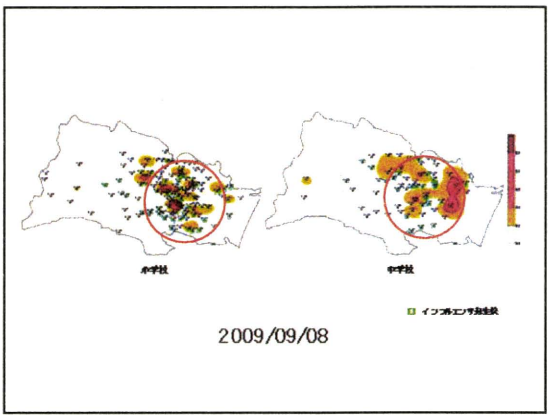

図4　9月8日の小、中学校の欠席状況クリギング図

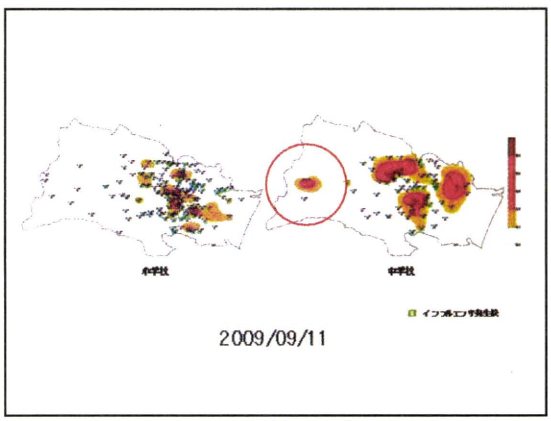

図5　9月11日の小、中学校の欠席状況クリギング図

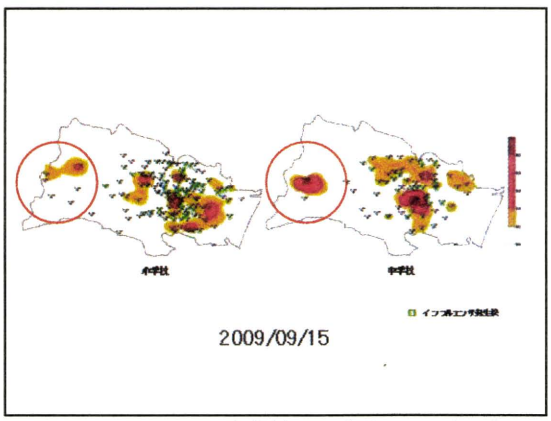

図6　9月15日の小、中学校の欠席状況クリギング図

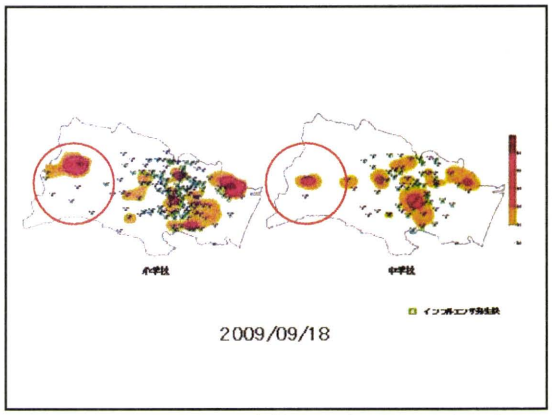

図7　9月18日の小、中学校の欠席状況クリギング図

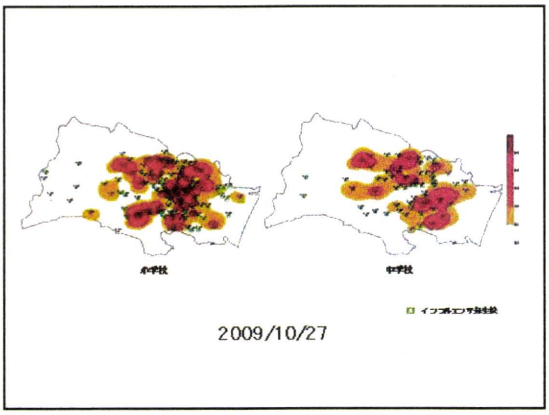

図8　10 月 27 日の小、中学校の欠席状況クリギング図

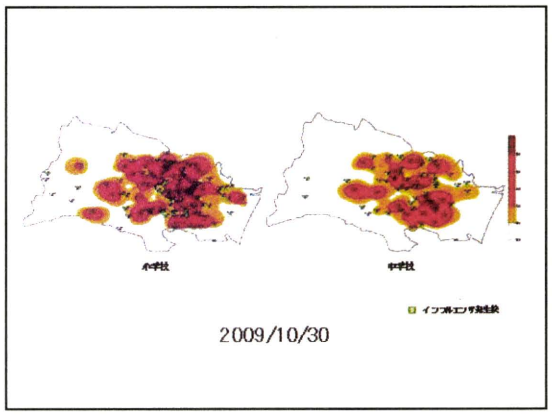

図9　10 月 30 日の小、中学校の欠席状況クリギング図

図 10　11 月 4 日の小、中学校の欠席状況クリギング図

研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Masatoshi Arikawa, Hideki Kaji,	Privacy functions in location based personal life content managers	The 18th Int'l Conf. on Geoinformatics 2010, Beijing, China, June 18 to 20, 2010	CD Proceedings		2010
Akira Mitsuyasu, Masatoshi Arikawa, Hideki Kaji	Proposal of a Web mapping service for managing and sharing drawing data of public works and its designprinciple in usability	The Asia GIS 2010 International Conference, Kaohsiung, Taiwan, 5 to 6 November 2010	CD Proceedings		2010
Ken'ichi Tsuruoka, Masatoshi Arikawa	A Mobile Authoring Environment for User-Generated Location Aware Audio Tours	The Asia GIS 2010 International Conference, Kaohsiung, Taiwan, 5 to 6 November 2010	CD Proceedings		2010

PRIVACY FUNCTIONS IN LOCATION BASED PERSONAL LIFE CONTENT MANAGERS

Hideki Kaji and Masatoshi Arikawa

2010

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PRIVACY FUNCTIONS IN LOCATION BASED PERSONAL LIFE CONTENT MANAGERS

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KEY WORDS: Personal Life Content, Location Based Service, Privacy, Information Sharing Levels, Mobile Computing

ABSTRACT:

In this paper, we will introduce a location-aware personal life content manager (laPLCm) and the functions of location privacy for data representation, query, transmission and positioning methods on laPLCm. laPLCm allows users to be reminded and access their own personal life content by spatial keys of the content and the users in their real lives. Examples of personal life content representing past, present and future events are diary, schedule, to-do list, GPS logs, photos and videos which are recorded, created and stored with our daily mobile devices. Personal life content cannot be fully treated on current commercial LBS. Our proposed laPLCm gives a new platform for users to easily generate their own LBS for themselves, their families, friends and colleagues using their personal life content in the form of blog as well as original privacy functions. The functions of setting levels of information sharing to each of persons and groups flexibly realize part of the privacy for data in our system. Personal mapping services introduced in the paper prevent from recoding positions of users in the servers of web mapping providers. Our proposed self-positioning methods are also significant to keep the location privacy for positioning methods. Furthermore, we demonstrate our prototype system based on the architecture of location privacy, and discuss usability, feasibility and sustainability for the system with comparison of present commercial LBS.

1. INTRODUCTION

Location based services (LBS) grow popular and many people use these kinds of services on their mobile phones and other mobile devices with GPS receivers. For example, users can find their positions on maps, search points of interest (POI) around them, generate itineraries of their trips using complex time tables of public transportation, and navigate in the real world (Arikawa et al., 2007). On the other hand, there are many users who fear a lack of security and privacy of their location information (Dobson et al., 2003; Nouwt, 2008). These users think service providers may estimate their activities and movement patterns in life from their location information if they keep using commercial LBS.

On the Internet, people make personal life content, for example records of dairy activities, their opinions for interesting things, to-do lists and schedules as user generated contents like blog, twitter (Twitter, 2009), SNS (Boyd, D. et al., 2007) and video/photo sharing services. These systems have various privacy policies and features for privacy setting so users can control sharing level of their content. One of the reasons why people keep recording on blogs is not only informing other users about author's opinions, but also retrieving them as needed (Nardi et al., 2004). Most of the records, however, might never be accessed in their lives, and many of these personal records include spatial information which can be provided as spatial content in LBS. From this point, we developed and started experiment of blog based location-aware personal life content manager (laPLCm). laPLCm can provide users with their personal information or services based on locations and their personal information which are managed in blog. Also, users can easily launch user-generated LBS for themselves as well as other users on the Internet. On the other hand, privacy factor becomes much more important when LBS have functions to treat personal life content. In this paper, we focus on privacy settings for our proposed laPLCm and our developed prototype system of it.

2. PRIVACY SETTINGS ON SOME SERVICES

In this section, we will introduce treatments of privacy on some Internet services.

2.1 Social Network Service (SNS)

SNS is one of the most popular services on the Web. It provides environments for building online communities. Boyd and Ellison defined that it allows individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system (Boyb, D. et al., 2003). Facebook (Facebook, 2009) is a popular SNS that was designed for communication between students at first. It has simple privacy setting for sharing user's profiles. Users can set statuses to each attribute like basic information (e.g. sex, birthday, home town and political view), self introduction (e.g. activity, hobby, music, TV programs) and friend list to limit

* Corresponding author. This is useful to know for communication with the appropriate person in cases with more than one author.

accessing from other users. Users can choose a restriction status from four options.

- **Everyone**
- **Friends of Friends**
- **Only Friends**
- **Custom**

Authors can add restricted friends if you set the status to **Custom**. Furthermore, authors can set posting ability to their content from other users. This feature is easy to set restriction but it cannot set these statuses to each post separately so it has lack of flexibility

2.2 Google Latitude

Google Latitude (Google Inc., 2009a) provides an environment for sharing one's current location information and messages with Gmail (Google Inc., 2009b) users as a Web service. Its location sharing setting is very simple. Users set some sharing status of his/her location information for each Gmail contact. There are four statuses on acceptance of location information sharing.

- Accept and share back
- Accept, but hide my location
- Do not accept
- Block

Furthermore, users can choose a detail of location information from three levels

- Share best available location
- Share city level location only
- Hide from this friend

Additionally, users can set their location by manual pointing instead of using GPS. This setting feature is very simple, but it may take much time if you have a lot of Gmail contacts.

3. LOCATION-AWARE PERSONAL LIFE CONTNET MANAGER

We developed a prototype system to realize new Location-Aware Personal Life Content Manager (laPLCm). On this system, to create and store personal life content with location information, we adopted blog for a base system of the LBS server. We thought, blog had become popular on the Internet and many people have or had their own blogs. It is an easy way to make personal life content on the Internet. Thus, we decided to utilize location information on a new blog system so that users can create spatial personal life content easily. Furthermore, we selected mobile phones as a platform for LBS client applications. Latest mobile phones equipped with various features such as GPS receiver, motion sensor, digital compass, digital camera and network accessibility that provide a good environment for using spatial personal life content in the real world.

3.1 Architecture of laPLCm

Figure 1 shows the architecture of our laPLCm which is designed as an open platform to realize laPLCm based on protocols of the Internet. The system is constructed with the place enhanced blog and the LBS client on mobile phones. Our LBS server, that is, a place enhanced blog application is coded by Perl as a Web CGI application, thus they are working on Web servers and using HTTPS to communicate with Web browsers and LBS clients. LBS clients connect the interface script to interactively retrieve, and display POIs from the place enhanced blog through user-friendly GUI on the screen of a mobile phone.

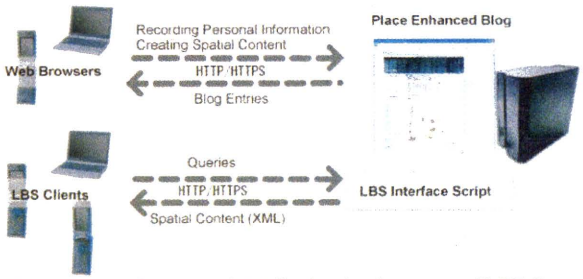
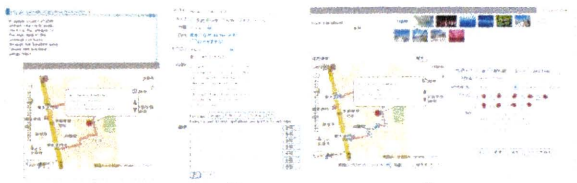


Figure 1. Architecture of pTalk, that is, the name of laPLCm.

3.2 Place Enhanced Blog



A B C

Figure 2. Entry view (A), entry input form (B) and place information input form (C). (Map images: copyright 2009 Google, copyright 2009 ZENRIN)

Place enhanced blog provides users with an extended function of dealing with spatial information such as point of interest (POI) and area of interest (AOI) in addition to general functions of common blog systems such as browsing and managing personal information. Users add place descriptions to their blog entries through blog input interfaces on Web browsers. To create an entry and corresponding place descriptions, users need to use two input forms, one is entry input form a simple input form same as normal blogs. Other one is a place information input form. Users can create multiple place objects on it. When users create a new place object, they point a target place on the map view and fill some fields for descriptions of this object. These place objects are included with this new entry (Figure 2).

3.3 Personal Map Content

On our system, instead of using map images from open global map services, users can use personal map images as base maps on LBS. Arbitrary uploaded images like hand drawn images, photos and captured facility maps are utilized for personal maps. A content using personal maps, personal map content, includes spatial objects same as global map content on our LBS, they are placed by local X-Y coordinates of a personal map. Additionally all spatial objects on our LBS are allowed to make a link to other spatial object on another global/personal map content. These links lead from a global content to a personal content, or represent connections between a personal content and other personal content. Using these links, users are able to go into personal map and go back to global map quickly. Furthermore, it is utilized to represent connections between facility maps of each floor and some buildings. (Figure 3)

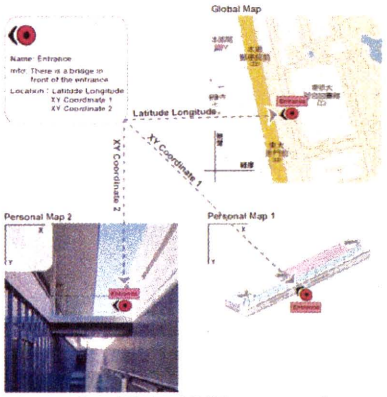


Figure 3. An example of linked POI on several personal maps.

Following two figures (Figure 4, 5) represent sample personal map content. Figure 4, this content uses a station's facility map. The facility map is not north up and it is a little complex to go to the north exit from platforms of super express train. It indicate a route to the north gate, and users can approach to the north gate easily by tracking the route (the red line) on this personal map content, when they arrive at this station by super express train.

Figure 5 represents pedestrian navigation content using sequential photos. To follow links of spatial objects is similar to turning over photos and users look for same landscape in each photo for self-positioning and self-navigation.

In personal map content, users only use self-positioning, but we think if entrance points are easy to recognize, users can adjust their positions by themselves, so they can continue walking in personal map content with our LBS client. Also personal map content does not use latitude-longitude coordinates for positioning, thus users can hide from logs of global map services.

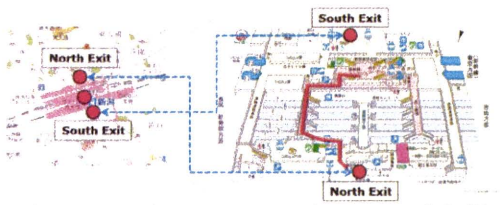


Figure 4. A personal map content using captured facility map that leads travellers from platform of super express to the north gate. (Facility map: (c) KOTSUSHINBUNSHA)

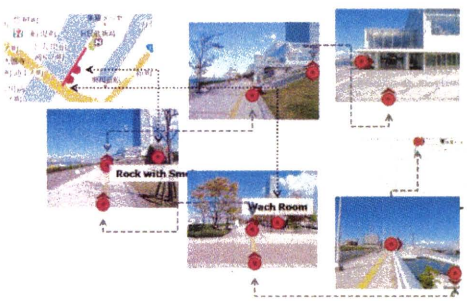


Figure 5. A personal map content by sequential photos. It represents a path from a bridge to a convention hall using sequential photos.

4. CONNECTION BETWEEN WORDS AND PLACE INFORMATION

On our blog, spatial information and a blog entry have a loose relationship normally. Sometimes multiple spatial objects, while a spatial object represents spatial information on a map, can be included in an entry, and blog readers need to find correspondence relationships between a part of the entry text and a spatial object from the context of the text. For setting an explicit relationship between a part of text and a place object and for assigning restriction levels for privacy to a spatial object, we prepared a pair of POI tags, [poi #] and [:poi]. A POI tag is composed of a start tag [poi #] including the number (#) represents a target spatial object, and an end tag [:poi] which consists of a colon and the tag word "poi". Owners can write descriptions with other various tags between the start and end POI tags. When a POI tags are embraced group tags, the target spatial object is assigned a limitation of data access for browsing. Thus, only permitted spatial objects of a reader are displayed on a digital map on a blog site and screen on a LBS client. Using this feature, users can add flexible restrictions of data access control to spatial objects.

On our blog, despite of using angle brackets "< >" for representing tags, it uses square brackets "[ ]". This avoids several security issues, for example, cross site scripting, session hijacking and so on, without any complicated process.

When a user makes mistype of control tags on his/her blog, layout and linking tags, [image] and [poi] don't have serious problem. But if users write wrong tag style on access control tags, group, it has possibilities of serious privacy leak. We think users can avoid it using some inputting and confirming functions. Thus we provide users with tags placing function places tags on head and tail of a selected substring then users need to add attributes to placed tags, and preview function before publishing a new entry on our blog. It will reduce mistypes and problems.

5. PRIVACY SETTINGS ON LAPLCM

5.1 Levels of Group Sharing for Blog Documents in Part

Our place-enhanced blog has sharing group settings same as some normal blogs and SNS. However, those blogs and SNS can set only one sharing level to each record, on our blog, authors can set flexible access restrictions not only whole text of each blog entry but also each word in the blog entry text using these sharing groups. For example, the following texts include access controlled partial texts. A writer can set a restriction level in part of the text for information sharing with all friends. A line headed by "A part" can be shown to friends of "Group A", a line of "B part" can be also accessed by friends of "Group B".

> Today, I went to my office, 30km far from my house, by bicycle.
> *(A part) My office is here*
> It needed 2 hours to reach the office.
> When I returned, I have spent 3 hours on the way because of fatigue and against wind
> *(B part) I'm sorry for late for the dinner party.*

Users on the author's friend list can show the following text.

Today, I went to my office, 30km far from my house, by bicycle.
It needed 2 hours to reach the office.
When I returned, I have spent 3 hours on the way because of fatigue and against wind

"Group A" users on the list can show additionally the A part line. So, users of "Group B" can show the B part line.

We will explain about sharing details and how to set restrictions to each word text. There are four levels and groups for sharing blog entries (Table 3). Sharing levels express of showing of each entry and arbitrary parts of the blog text. Sharing groups are defined as lists of users for sharing. Users can make multiple sharing groups on their accounts.

Table 3. Sharing levels of laPLCm

Sharing group / Sharing level				
Private				
Group1	Group2	Group3	Group4	...
Friend				
Unlisted / Public				

*Names of sharing level and group are same without Public level

Our proposed system provides enough functions of restrictions for users to access part of text by setting sharing levels. A user can assign all other users to a sharing group. **Group** level is separated into subgroups, and when a user is put in Group level, the user has to be put in a subgroup like "Group1". Users can make arbitrary subgroups on Group level.

- Unlisted users can only show "Public" level contents.
- Friend level users can access "Public" and "Friend" level contents.
- Group level users can show "Public", "Friend" and their included sub group level contents. For instance, if U is in Group1, U can show "Public", "Friend" and "Group1" level contents.
- Private level users can show all content of this author.

When users set restrictions for blog text, first, an Author chooses sharing level of a blog entry. Second, put some pairs of group tag, [group foo] [:group], in the blog text for setting restriction to arbitrary parts of the text. Following text is the sample of usage of group tags.

(Whole text: Friend)
Today, I went to my office, 30km far from my house, by bicycle.
[group A] My office is here[:group]
It needed 2 hours to reach the office.
When I returned, I have spent 3 hours on the way because of fatigue and against wind
[group B] I'm sorry for late for the dinner party.[:group]

Our blog provide flexible restrictions of blog texts with users using this group tags. A user just makes a friend list on the user's blog account to use this access control.

5.2 Personal Mapping Services

It is an important problem that locations of users are recorded to servers of commercial map providers when web mapping services are used from mobile computing environment with GPS receivers, because the queries to obtain map data around their positions mean that users always inform their positions to web mapping servers. Our proposed personal mapping services prevent from the recording of users' locations as the log of web mapping. The personal mapping services serves as proxy servers of web mapping services in additions to personal map repositories. If the personal mapping servers have cache data of maps of users' interests which have been fetched from web mapping servers before, maps of their interests are available through the personal mapping services without any accesses to web mapping servers. If the personal mapping servers do not have cache data of maps of their interests to visit in future but their planned routes have already known for users and their navigation scheduler software, map prefetching transactions following the planned routes can be executed to store the cache data of maps of their interests in advance. The prefetching spatial queries can be recorded in web mapping servers, but real-time position tracking is prevented from recording. Also, the LBS clients on mobile devices can use secured private transmission protocol to make spatial queries to and to receiving spatial data from personal mapping servers. For example, cached map data can be transformed by intended differential coordinates as transmission data on the Internet. Furthermore, the spatial data transmissions between the LBS client applications and personal mapping server applications can be asynchronous to hide real-time positions of users.

5.3 Self-positioning

Our developing LBS client applications can cover indoor navigations using indoor map content and self-positioning function. GPS signal is usually not available indoor or is inaccurate. Our proposed self-positioning function allows users to easily set their position with natural computer-human interactions. Network data representing ways of both indoor and outdoor are used for the basis of the positioning. Users' positions are on the ways. Default speed of users' movements may be three kilo meters per hour. The positions of users are automatically moving on the ways of the displaying map at the constant setting speed which can be easily changed. Also, users can stop, forward, and backward the movement of their positions using user-friendly interactions like a mobile music player. On branch points, users can easily choose their ways by simple selecting operations. The user friendly self-positioning interfaces can be considered tiresome, but many subjects do not feel tiresome in the operation of self-positioning. They felt fun the self-positioning like the operations of computer games. The self-positioning function is important for indoor LBS and navigation from location privacy as well as practical viewpoints for universal navigation systems. If users use the self-positioning, they need not communicate with global online positioning services, including assisted GPS, Wi-Fi Positioning and so no, which can record the real-time positions of users on the servers of global positioning providers.

Navigation on cars and other high speed or imbalance vehicles needs hi accurate positioning and correct information, because drivers need to watch and decide their direction in short time, if their position on navigation systems provide drivers with inaccurate information, it may happen traffic accident. On the other hand, pedestrians have more allowance to check and

operate a mobile device to use LBS client, because they can stop walking and step aside any time. This means users can take time to match their position and choose useful information on LBS so we think it suits self-positioning and using unsure content on user generated content.

6. EXPERIMENT IN REAL SITES

We had an experiment to demonstrate the efficiency of our system as a location based service. We tried out the system in a class. Twelve graduate students of the University of Tokyo used our system. Students created town guide content on it, then they experienced these content on each site.

6.1 Creating Personal Spatial Content

Students created spatial content or town guide content as an assignment after a lecture using our system for an hour. The content was a walking guide for an area around Tokyo. Students created some entries including related POIs and lines on the place enhanced blog. POIs represent favourite restaurants, interesting hobby shops, view points and so on. Lines represent some route to walk the area.

Most students created their content in only one night. The target areas and numbers of spatial objects in the content are shown in Table 4. According to time stamps of each entry and access log of our Web server, they did not spend much time for creating their content.

Table 4. Numbers of Entries and Spatial Objects in each of Spatial Content Created by Students

	Route	POI	Entry	Making
S1	3	29	3	-
S2	3	27	30	2:40
S3	1	13	14	0:50
S4	3	22	25	4:00
S5	2	20	22	0:40
S6	1	20	21	1:00
S7	0	20	20	3:00
S8	1	7	7	0:30
S9	1	21	22	1:00
S10	2	20	22	1:20
S11	4	20	24	2:00
S12	0	13	13	2:30

*Time is a span from the first entry posted to the last entry posted. S1 did not post entries continuously thus S1's time is not filled.

6.2 Experience on the Sites

Students experienced the spatial content with each other using LBS client application on mobile phones. Current our LBS client application displays multiple points of interests with map images on screen. Users can read description of each point of interest and a text of corresponding entry in a window. If there is one or more dashed poly lines on map images, users can start scrolling maps along a poly line automatically by select and start walking on maps function. To retrieve place information around a user, it uses key word or a latitude and longitude coordinate that it is pointed by center point of the map view or GPS on a mobile phone. Additionally, users set down target users of our blog, target term and radius for searching. On the site, students tracked a route in the content and checked real places of POI described. They can choose arbitrary route and change his/her route to another any time.

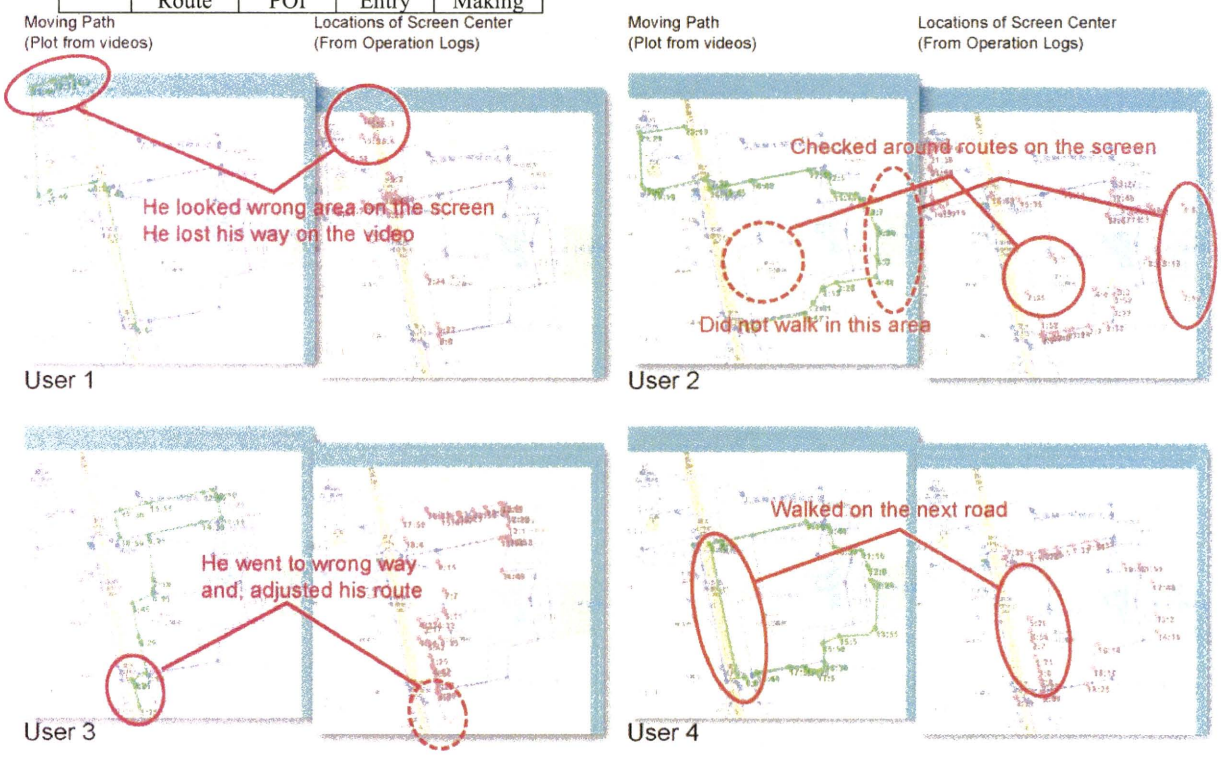


Figure 6. Walked paths and logged points of experiences on the Hongo Campus

Our prototype LBS client does not use GPS functions, thus its users must adjust their current positions on the map displayed the screens of their mobile phones. Some students lost their ways when they experienced the navigations of our LBS. There are some students' feedbacks after the experiment as follows:

- The mobile phone client took time to be getting used to.
- It is interesting to relive the experiences of someone else.
- I was prone to get lost with GPS-less navigation.
- It was easy and useful to create spatial information on the place enhanced blog.

Figure 6 shows some pair of plots of moving paths and plots of locations of screen center on maps that users used a content to guide around Hongo Campus of the University of Tokyo. Usually, these tester students are based on the Kashiwa Campus that is located 30km far from Hongo, and they are not familiar with the Hongo Campus. These maps represent user's matching accuracy and mismatching points in the experiences. On our system, users need to make self-positioning to reduce using GPS thus matching accuracy is an index of usability. Red circles mean characteristic points of user behavior. User2 used the client easily and he could walk in the campus along multiple routes without losing his way, furthermore he checked around routes using map scroll feature. User3, at first, went to wrong direction, but he realized his mistake soon and returned to the correct way. User4 walked on the next road of the target route then he adjusted his position at the junction of these two roads. User1 lost his way and he entered an area that maps of the area were not prepared on our prototype map server. Thus, he could not return to any route.

All students began to check the mobile phone continuously, when they missed their right locations. According to video records of their behavior, we presumed that they were checking their locations and spatial information around them, when they did not operate their mobile phones. Also, according to these points of Figure 6, it was easy for users to match their locations without GPS and other sensors, and it proved that our proposed route based navigation method worked well.

7. CONCLUSION

In this paper, we have proposed the laPLCm framework and reported our implemented prototype system of the laPLCm for using personal life content with reasonable privacy functions. The prototype system provided users with a useful environment to create and use personal life content with spatial information as an extended blog system. Then, we confirmed the effectiveness of our proposed laPLCm. Useful interfaces and easy operations of place enhanced blog allows trial users to create many blog entries as a spatial content on the blog in a short time, after only a simple short lecture for using our system. Flexible and simple privacy setting for personal spatial content is important to treat personal location information and spatial content on LBS. Our proposed location privacy functions may enable users to keep location privacy in their daily lives.

It is not enough that only one commercial LBS contains all personal spatial information. Therefore, it is important to integrate between laPLCm and commercial LBS. For instance, when a user walks around Akihabara downtown in Tokyo, this system retrieves user's to-buy list in personal records and related shops' information on the commercial services, then this information is displayed on his/her mobile device synchronized with places of the users. Pushing users' past blog entries to each user can make them remember past forgotten memories and clarify their present situation from the life-span viewpoint. We have proposed a place enhanced blog for laPLCm in this paper. LBS are generally developed on the commercial telecommunication network services, and are usually not open in technical and use senses. Our proposal of place enhanced blogs is open on the platform of the Internet. Individuals can create and modify their own services by themselves using Web browsers and special software on mobile phones.

Easy manual self-positioning methods of both choosing routes of sidewalk networks and controlling walking mode such as walking, stopping, returning and running are significant to keep the location privacy for positioning methods. GPS and other positioning sensors can be also used with the manual positioning methods, but they are used in the pull style, not in the push style to allow users to be aware of the location of ourselves recorded by global positioning providers.

References from Journals:

Boyd, D., Ellison, N., 2007. Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication*, 13(1), pp. 210-230.

Nouwt, S., 2008, Reasonable Expectations of Geo-Privacy? *SCRIPTed – A Journal of Law*, 5(2), pp. 375-403.

References from Other Literature:

Nardi, A. B., Schiano, J. D., Gumbrecht, M., Swartz, L. 2004. Why we blog, *Communications of the ACM*, Vol. 47, Issue 12, pp. 41-46.

Dobson, J. E., Fisher, P. F., 2003. Geoslavery, *IEEE Technology and Society Magazine*, Vol. 22, Issue 1, pp. 47-52.

References from websites:

Moons, T., 1997. Report on the Joint ISPRS Commission III/IV Workshop "3D Reconstruction and Modeling of Topographic Objects", Stuttgart, Germany. http://www.radig.informatik.tu-muenchen.de/ISPRS/WG-III4-IV2-Report.html (accessed 28 Sep. 1999)

Facebook Inc., 2009, Facebook, Palo Alto, United States. http://www.facebook.com/ (accessed 08 Dec. 2009)

Google Inc., 2009a, Google Latitude, Mountain View, United States. http://www.google.com/latitude/ (accessed 08 Dec. 2009)

Google Inc., 2009b, Gmail, Mountain View, United States. http://mail.google.com/ (accessed 08 Dec. 2009)

Twitter Inc., 2009, Twitter, San Francisco, United States. http://twitter.com/ (accessed 08 Dec. 2009)

Proposal and Implementation of a Web Service for Geovisualizing and Managing Drawing Data of Public Works

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Proposal and Implementation of a Web Service for Geovisualizing and Managing Drawing Data of Public Works

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Abstract

Modern computerization of drawings has resulted in the dissemination of electronic delivery in public works in Japan. Active reuse of the digitization drawings have been expected to improve the productivity of public works, however the reuse has not yet to achieve because the environment of the structure and usability of information sharing system has not matured yet. We propose a new platform for users to geovisualize and manage the digitization drawings on a user-friendly Web mapping service improving both the environment and user interface of the system for displaying images of the drawings in order to activate the reuse of digitization drawings in public works. A prototype of the platform is called *Location Manager for Drawings (LMD)*.The significance and perspectives of our proposed platform are discussed in this paper.

Keywords: Web mapping; Spatial metadata; Usability; Public works; Geovisualization

1. Introduction

Civil engineers usually deliver electronic data to public offices in public works, however there is little sharing the electronic data in public works. The drawing data are grouped into particular public works, but spatial key retrieval functions of the drawings of a large mount of public works are not provided in the current platforms of dealing with them because the spatial key retrieval is considered less important for most of the civil engineers.

Modern computerization of drawings has resulted in the dissemination of electronic delivery in public works in Japan. Reuse of the drawings have been expected to improve the productivity of public works, however the reuse is not active. This paper proposes a new platform for users to geovisualize and to manage the digitization drawings on a user-friendly Web mapping service in order to activate the reuse of digitization drawings in public works.

2. Overview of the Research

Considering the existing conditions, we will achieve higher productivity by developing a common platform for search, reference and reuse of drawings. We are

now developing the service of geovisualizing and managing drawing data on a Web mapping. Our objective is to promote the use of drawings for offering the platform of information distribution on map interface with this service. Figure 1 shows the overview configuration of *LMD* (*Location Manager of Drawings*) which we are currently developing. The followings are basic functions of LMD.

(1) Geovisualization of drawings
(2) Editing spatial attributes of drawings with user-friendly user interfaces
(3) Easy way of publishing users' contributed drawings as well as other related data
(4) User account management
(5) Group setting and data sharing
(6) Uploading/Downloading the project data, including drawing data, to LMD
(7) Decoding/ Encoding the project data on the fly while uploading and downloading

LMD is made up as a Web application and all of the data are managed on the system server. It is made of the Web application part and the Web interface part. The Web application part handles data on the server side. The Web interface part runs on the Web browser to show users the projects and to prompt users to input data. There is a database on a server for managing the projects and for archiving files for electronic deliveries. On the part of the Web interface, we use *Denshikokudo Web System* (http://portal.cyberjapan.jp/) provided by Geospatial Information Authority of Japan in order to show the location of drawings on maps in Japan.

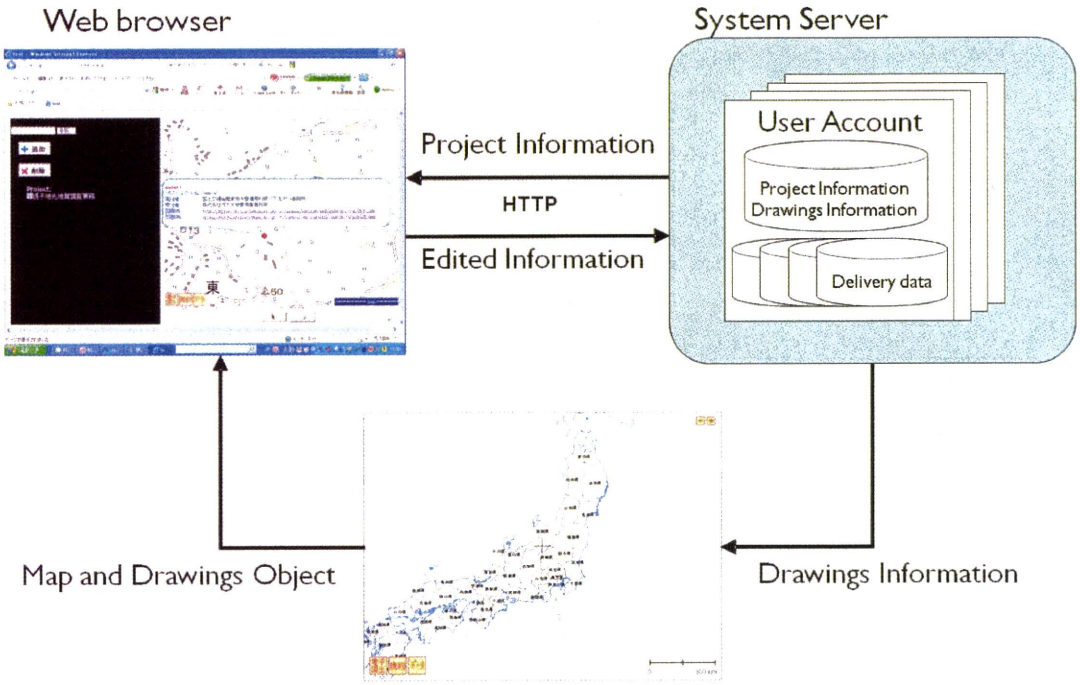

Fig.1 Overview configuration of our prototype of a platform of sharing and managing drawings of public works using functions of geovisualization, that is, LMD (Location Manager for Drawings)

There are two main functions of LMD. The first function allows us to choose types of views for drawings and their related information. For example, users can easily find the corresponding points included in both drawings and the corresponding contents. The second function allows users to easily understand locations of drawings with thumbnail images representing them on the Web map.

3. Related Work

The Geospatial Information Distribution Consortium (http://parma.csis.u-tokyo.ac.jp/), that is organized in Center for Spatial Information Science of the University of Tokyo has provided a Web mapping service to the members to retrieve various geospatial data including community facility, road information, and tourism information. The Web service is useful for simple uses, but it may need to improve view functions to support users who are interested in retrieving drawings among a large numbers of drawings with direct browsing of thumb nail images for drawings. The current Web mapping cannot help users setting difficult attribute conditions for retrieving drawings from the databases. Examples of the difficult attributes are types of public works and types of drawings.

The ground information database (http://www.kunijiban.pwri.go.jp/) offered by Japan's Ministry of Land, Infrastructure, Transport and Tourism are published to provide XML data of geological column stored in databases to follow links from pop-up menu on the Web mapping. Table form data are also available. They are useful for users to grasp the brief of the inspection and works of construction. The Web service is considered a case of success. One of the reasons of the success is that the Web mapping services focus on only boring data, and established excellent user interfaces of the services.

4. Conclusion

We proposed a new platform to enable users of civil engineers to share and reuse drawings of public works using geovisualization functions. The significance of spatial information management for the drawings is not common in the community of civil engineers. Our approach tries to propagate the significance of spatial information management to a wide variety of engineers to activate the reuse and share of digital data including drawing data of public works.

The fixed graphical user interface for geovisualization of drawings of public works is not appropriate for both different drawings and users. Therefore, we prepare several types of viewing and sorting drawing data depending on users' intended uses so that the system of geomanaging and geovisualizing the drawing data could be more adaptive and flexible for all users to like to use it. The system is supposed to provide better environments with many different users to share and to edit drawings based on groupware functions of it. We are now trying to increase more functions on LMD. An example of it is the function for information sharing with text messages and text encoding services to call up the locations of the drawings by analyzing XML data representing drawings using textual and geographic analysis techniques.

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