FarmTracking® - alerts and Tracking in a Farming Context

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ABSTRACT

FarmTracking® aims to provide the farmer with a unique opportunity for receiving practice-aimed information and decision support delivered at the right place at the right time. FarmTracking is a concept and a system that utilizes the capabilities of the smartphone in combination with central databases and GIS based to provide the farmer with context specific notifications and alerts. A generic framework able to fulfill a number of requirements has been developed, and this framework has shown its value through working prototypes for handling logbook for manure storage tanks and for retrieving field specific information.

Keywords: Smartphone, app, context aware, localization, Denmark.

1. INTRODUCTION

In Denmark, running a modern farm demands that you are able to handle a wide variety of technical equipment; manage a number of farm labors and contract workers and ensure that all activities are performed according to legal rules and legislation. Decisions have to be made throughout the day. Ideally these decisions should be data-driven and not just rely on experience and gut feelings.

Rapid developments in sensors and wireless systems bring us a future, where farms will be constantly monitored in 'the good way'. Every change in growth conditions, every movement, every piece of work carried out in the field with the machines will be recorded in the Farm Management Information System (FMIS). In Denmark, Knowledge Center of Agriculture has foreseen this development and has by its online Danish Field Database (DFD) built a foundation that makes it possible to handle vast amounts of location specific data. DFD provides detailed and updated information about more than 2.1 million hectares or 80 % of all agricultural land in Denmark.

So far it has been an obstacle that much of the work carried out on a farm occurs while the farmer is separated from his PC. This means that the working situation and the use of data from e.g. DFD have been sharply divided. And although smartphones have found their way to the farmer's pocket, it is still too complicated using the smartphone (as a pc) to actively retrieve relevant decision supporting data.

It no longer has to be like that. With GPS equipped and wireless connected personnel devices such as the smartphone or wearable's, it now possible to develop context-aware systems where the user gets his or her personal data made available at the time and in the place where they are most needed. Context-aware systems take into account contextual information in order to adapt their operations to the current context without explicit user intervention.

With FarmTracking our aim is to provide farmers with a unique opportunity for receiving practice-aimed information and decision support delivered at the right place at the right time. Through FarmTracking alerts and information will be instantly at hand or come to the farmer when needed without him having actively to request it. Our expectations is, that farmers will find it both labor-saving and thereby a help to increase efficiency by – as appropriate - receiving information and reminders, so that he can quickly correct any deficiencies. It will help to strengthen the individual farm productivity growth and competitiveness while respecting environment and nature.

1.1 Survey – what functionality do farmers request?

Before we started developing FarmTracking, we surveyed amongst farmers their wishes for new agriculture specific functionality for their smartphones. A survey primo 2013 with more than 6.000 responses had shown, that 2 out of 3 mobiles amongst farmers were classic models, but the numbers also showed, that when buying a new mobile, 3 out of 4 farmers are choosing a smartphone (Hansen, 2013).

In a smaller survey in September 2013, 178 farmers responded on a number of questions about use of smartphone in relation to managing their farm. Amongst farmers owning a smartphone (57%), these are the most requested functionalities:

- Marking of the location of drainage pipes (70 %)
- Marking of the location of weed patches (60 %)
- Retrieval of field specific cropping or cultivation plan (52 %)
- Early warnings about diseases and bugs in crops (45 %)
- Legal restrictions on a specific field (33 %)

Responses from farmers not yet owning a smartphone showed a similar pattern but at a lower level of interest.

1.2 Apps for spot marking

How far can apps from Google Play or the AppStore bring us toward the wishes of farmers? Quite a long way; Hansen (2012a, 2012b) reviewed five spot marking apps for android (SpotPad, LocoNotes, Spoty, Spotmarker and GPS Bookmarker) and five for iOS (GPS Voice Recorder, GPS Bookmarker, GeoNote, GPSReminder and Pin Drop) and found, that the best of these apps are quite useful tools for 'stand-alone' spot marking.

However lack of integration with FMIS and not being able to communicate with and utilize data from DFD makes these apps insufficient to cover the needs of the professional farmer.

1.3 Generic requirements

Based on the survey amongst farmers, discussions with farmers and extension personnel and work with making a catalogue with use cases for FarmTracking (see 3.2), a number of requirements for a generic GIS-based application are outlined here. The common thread in these requirements is a desire to develop a strong framework, which can support different kind of functionalities, that on the basis of knowledge of the individual farmer's identity and position,

can refer to various databases and extract exactly the relevant information for this farmer and then send the data to him.

a. It must be possible for the user to receive notifications on his phone on the basis of location. *It is a basic premise that the user is notified using the phone's built-in notification system when he comes within a certain distance to a point.*

b. Notifications are provided within a very short time, when the user approaches the location which can trigger a notification. *It can be a rather limited period of time where the user is located near the position that triggers a message. Therefore it is necessary that an application continually knows where the user is, especially if he is in an area with locations, which holds notifications for release.*

c. The solution should be applied as widely as possible - i.e. for all possible types of notifications, both included in the scenarios we see today, but also those who potentially may come in the future. *It must be possible to give notifications based on position, but it should also be possible to send not site-specific notifications based on other attributes. It could, for example be a warning of pests in a particular type of crop variety or new legislation affecting specific farming systems etc.*

d. The application must dynamically adjust its querying for notifications and alerts. *Often business logic will be able to guide the need for querying. E.g. if the farmer has just checked his slurry tank and legislation demands checking once a month. In this case, the system should not continuously monitors the farmer's position, but instead simply inquire after the interval set by the application "Logbook for slurry tanks". It is also important that the application is able to take into account whether the farmer is in the proximity of places which can trigger notifications. If, for example, he is more than 10 kilometers away from the farm and its fields, there is no reason to poll every minute on whether he is near a slurry tank or is about to enter a field with patches of wild oats.*

e. The platform should allow for the user to change the status of a task to "Done". *This means that the user direct from FarmTracking must be able to invoke messages going back to connected applications notifying these, that he has taken action after receiving the notification.*

f. Notification must be given not only on the basis of point position, but also on the basis of whether the user is within a certain area. *There are types of notifications that relate to an area with relatively limited distribution. It may, for example. Be the location of a slurry tank or a patch with a history of having wild oats, etc.*

g. Battery life must to some extend be taken into consideration. *It is a known problem that the use of GPS functionality reduces battery life.*

h. The platform should be usable across different mobile platforms. *It shall be avoided developing a system that is so closely integrated into a specific platform - e.g. Android -*

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that it will incur substantial costs to make the transfer to iOS or Windows Phone.

i. Off-line scenarios are an issue which has to be handled. *There are places where mobile coverage is not optimal - especially in rural areas where farmers are operating.*

j. The user must be able to save locations on their mobile so that so that such locations later on can be used as trigger points for notifications.

k. The end user must have a clear perception of what is monitored and why. *As FarmTracking could give the user the impression that he was being watched, it is important that the user has a good understanding of how the platform uses data about his position, and it has to be very easy to turn it off.*

l. The application should be simple to use. *FarmTracking is a completely new type of application and it is obviously a requirement that it is easy for the user to understand the different screens.*

These requirements have been or will be dealt with as outlined in next section.

2. GENERIC FRAMEWORK

2.1 Platform
Initially, at the start of the project in 2013, a prototype of FarmTracking platform was developed for Windows Phone, as in-house development resources have strong competences with Windows development, so this gave us the fastest set-up to get started.

Since then and acknowledging distribution of mobile platforms amongst Danish farmers, it has been decided to deliver FarmTracking for Android, iOS and Windows Phone in mentioned order. Seen in that perspective, PhoneGap is now used as development platform.

2.2 It architecture
To fulfill requirements as listed in section 2, a number of choices have been made (each list item refers to corresponding requirement in section 2):

a. Implementation of notifications integrates directly into the phone's own notification system. This ensures that FarmTracking notifications works and can be handled in the same way as the user knows it from the phone's other apps.

b. To ensure that a notification is not "lost" because the user passes a notification point too fast, an option for each application to increase the polling frequency has been developed. This is implemented by letting the application constantly be in contact with the underlying FarmTracking server. Based on the knowledge of the user's current location - and about notifications are waiting for the user – logic determines how much time must elapse before the application again asks the FarmTracking application for the position.

c. Efforts have been invested in constructing FarmTracking holding as little information as possible. This means that the app will not distinguish between different types of business

regulations, but only aims to make sure to get relayed the notifications coming. It keeps information about the update frequency of each application, as this is necessary for applications called at the correct time.

d. To avoid unnecessary request for notifications, individual applications can forward requests as it fits in relation to the embedded knowledge about future notifications and the farmer's current location.

e. Until now, change of status of a notification e.g. to Done is implemented de-centralized in prototype apps for Logbook for slurrytanks and Mark Mobile, but it is prepared to be done directly from the Farm Tracking app.

f. Logic about when to trigger a notification – being a point or an area – is decentralized rather than in the FarmTracking framework. The core FarmTracking application keeps track of what notifications to send - including postponing and deleting them, etc. - but it is up to the individual decentralized application to determine when it is needed to keep track of whether the user is within a certain area.

g. To reduce battery drainage, use of GPS on the phone is not used continuously unless there is a demand from decentralized applications.

h. To reduce development cost in relation to different platforms, the part of the application that is platform-specific is made as thin as possible.

i. Off-line issues are still standing issues. Among other things, preliminary clarifications have shown that it must be carefully considered how potential interactions between different notifications shall be handled when online and synchronizing.

j. As the FarmTracking app does not hold business logic, a functionality for creating notification triggering hotspots will be placed in decentralized applications such as e.g. Logbook for Slurry Tanks.

k. To handle privacy concerns, the user will be asked whether GPS is to be turned on. In the current prototype implementation, GPS is enabled until the user actively turns it off.

l. To ensure simplicity and user-friendliness, FarmTracking is designed with as few and as simple screens as possible. Screen size is taken into consideration and if possible, standard functionalities are used.

The resulting it architecture is shown in fig.1. The basic flow is as follows:

FarmTracking app sends:
• User GIS position
• User credentials as a JWT Token

FarmTracking server component sends:
• One or more messages
• Update rate

It is then up to the individual application in the server part, to evaluate and return the messages that are appropriate to send to the user. The FarmTracking server handles returning such messages back to the FarmTracking app.
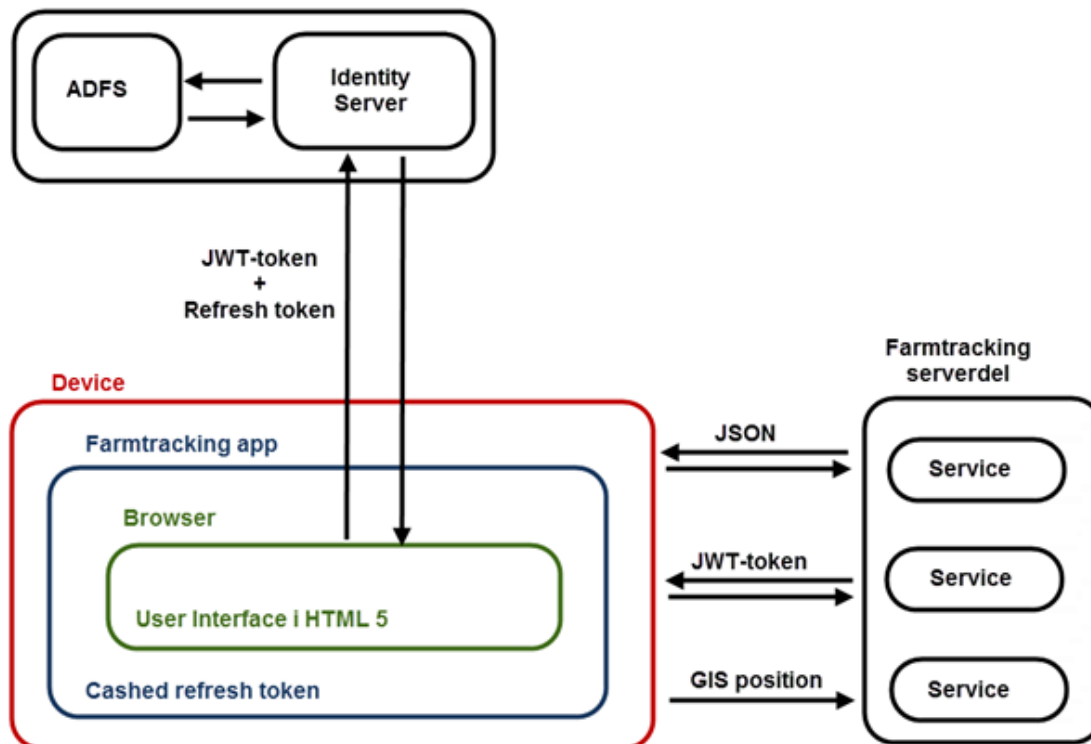

Figure 1. It architecture for the FarmTracking platform

3. FUNCTIONALITY

3.1 Implemented prototypes

An existing app Logbook for Slurry Tanks has been upgraded to interact with the FarmTracking platform. Danish farmers must once a month inspect the quality of crust upon their slurry tanks so to reduce evaporation of nitrogen. Until now, a farmer could use the app for documenting that he did inspect the slurry tank – if he remembers to do so.

The upgraded app helps him remember by using the FarmTracking framework. Each time he comes close to a slurry tank, and about one month has passed since last inspection, the app send him a notification that it is time to check the crust.

This functionality demands, that the position of the slurry tank is defined as a hotspot with potential for triggering a notification. Such hotspot could be defined using a pc and communicating with server side of Logbook for Slurry Tanks, but many farmers would find it difficult working with maps and positions. Therefore this functionality has been built into the Logbook for Slurry Tanks app. The farmer simply have to move close to the tank and press a "Set the tank location to your current position".

As another prototype, we have developed an app for notifying the farmer about deadline for the maintenance of permanent pasture. The case is based on a cross-compliance requirement, which in 2012 resulted in 300 farmers were hit by aid reduction because they did not comply with rules about maintenance of permanent pastures.

Deadline is 15th of September and some days before a notification is sent to farmers having fields of permanent pasture. This uses information from DFD and is independent of the farmers current position.

The notification consists of a header and a more descriptive text that explains what the notification is all about. Three buttons – a green Message; a yellow Post phone and a red Reject dominate the notification. By clicking the green button, the farmer will be presented with a list of notifications for each of his fields of permanent pasture covered by this specific cross-compliance requirement.

If the user moves into a field of permanent pasture, he will receive a notification telling him that he is on a field covered by cross-compliance requirement and suggesting him to take necessary action.

3.2 Use cases

To govern further development of FarmTracking, use cases for new functionalities has been collected in a catalogue (Aggerbo, 2014) and they are also injected into a crowdsourcing site run by Knowledge Center of Agriculture. A number of these ideas are presented here.

Wild oats alert- You go in a crop when your smartphone alerts. On the display you are told, that you are in an area, where you found wild oats last year.

Marking a stone- While plowing, you've hit a huge stone. To remove it, you need assistance from a backhoe loader. To be able to return to the position, you use FarmTracking for marking the spot as "Stone to be removed'. Until you do remove the stone, this marking will be saved in DFD and show up in Markkort Online.

Creating a drainage map- You have just finished laying down drainage pipes in a field and can still see traces of the work. You activate a tracing functionality in FarmTracking and walk or drive along drainage pipes thereby creating GPS data, which will upload to Markkort Online and here create a layer with a drainage map for this field.

Information about Marginal Zone[1] restrictions- You work in a field with a marginal zone and want more information about its precise location. Using your position, FarmTracking retrieves this information from DFD.

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[1] A Marginal Zone law prohibits the use of fertilizers and pesticides within 10 meters of streams and lakes

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Weed Spraying- Together with your adviser, you are inspecting a field and need to know exact information about realized and planned sprayings. FarmTrackings 'Show field information' serves you these data.

Legislation- You have finished plowing of a field and are ready to begin plowing another field. Suddenly you're in doubt – is it legal to plow this field at this time? – Should it stay green? Using 'Show field information' you can see all legal details about this field.

Rules for using sewage sludge- You are applying sewage sludge to a number of fields, and as you know that use of sewage sludge is strictly regulated, you use FarmTracking to check while you are driving, so you avoid areas which received sewage sludge two years ago.

Agri-environmental area- The weather forecast promises dry and warm weather, and consider therefore mowing grass for hay making on your agri-environmental areas. A quick look-up using FarmTracking ensures you that it is legal to do so at this time.

Locate drain pipes- Problems with wet spots on a field have sent you in with your backhoe loader. Using FarmTracking, you are able to start digging right away and soon you have opened the pipe and start cleaning it.

Cross-compliance[2] issues- You are in a newly harvested wheat field with a JB4 soil type and now you are unsure if it is legal to tillage this field now given that you have planned spring barley as next crop – and if you make a mistake – will you be hit by cross-compliance? FarmTracking answers your questions by communicating DFD.

Find the right field- You've just employed a new farmhand and instruct him to use FarmTracking each time you send him to do some work in a field, so to ensure that he is in the right field.

Follow-up on fertilizing plan- You are inspecting crops together with your adviser and notice a field with weak growth. You turn to FarmTracking activating 'Show field information' followed by 'Show applied fertilizer' and are from DFD served info on applied fertilizer by date, type and kg nutrient.

Preventing theft- All your machines are equipped with a small tracking device, which will alert you through FarmTracking, if the machine is moved outside boundaries defined by you.

Location-based guidance- One of your employees is at an automatic feeding system and has forgotten how this calibrating loads cells cleaning. With FarmTracking, he is taken almost directly to a specific guidance in both PDF format and video. The instructions come from a central system at Knowledge Center of Agriculture.

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[2] Cross-compliance is a mechanism that links direct payments to compliance by farmers with basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental condition

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Ad hoc farm specific location-based guidance- Thanks to integration with Recho (Apptitude Aps, 2014), the farmer uses FarmTracking to leave spoken messages at specific locations. A stack with silage has to be covered and while standing looking at the stack, the farmer speaks instructions. Later – then the employee comes around to do the job, he activates FarmTracking and are immediately notified, that a spoken message is placed at this location. Just one click, and he is listening to the instructions.

4. PERSPECTIVE

By using the FarmTracking framework, it is now possible to let data and information "find" the farmer just when he need these instead of him having to actively search for these. This will result in better decisions and that tasks are performed timely and documented in a workflow. With FarmTracking the farmer gets a unique opportunity to learn what he does well and what he needs to do differently to improve.

The generic nature of FarmTracking means that the concept and framework will be applicable on other devices than smartphones. Google Glasses are for sure going to be a potential interface between FarmTracking and the farmer but we might see the glasses being overtaking by smart watches, as they will be more handy for people not wearing normal glasses, and thanks to FarmTrackings context-awareness and the resulting direct and simple interaction with devices, smart watches might turn out to be a preferred delivery platform for FarmTracking.

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